

WIRED

UK EDITION

featuring
noma's
→ **René**
Redzepi

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BEST RESTAURANT**

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Official fuel consumption figures for the all-new Audi R8 Coupé V10 range in mpg (l/100km) from: Urban 16.1 (17.5) – 16.9 (16.7), Extra Urban 30.4 (9.3) – 33.6 (8.4), Combined 23.0 (12.3) – 24.8 (11.4). CO₂ emissions: 287 – 272g/km. Fuel consumption and CO₂ figures are obtained under standardised EU test conditions (Directive 93/116/EEC). This allows a direct comparison between different manufacturer models but may not represent the actual fuel consumption achieved in 'real world' driving conditions. Optional wheels may affect emissions and fuel consumption figures. More information is available on the Audi website at audi.co.uk and at dft.gov.uk/vca. Images used for illustrative purposes only. Car shown features optional equipment and optional Audi exclusive paint.

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The troll troller

Online vigilante James McGibney says he's protecting the web from bullies. But the world of bully-baiting has its own murky ethics

James McGibney at
Battery Mendell,
an old military facility
in San Francisco





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Pakistan's rogue glacier

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START

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MPG figures are achieved under official EU test conditions, intended as a guide for comparative purposes only and may not reflect actual on-the-road driving conditions. Model shown is a 208 Hatchback 1.2L PureTech 82 5 door Allure with 16" Titane Gloss Black Alloys, with metallic paint, Cielo Panoramic Roof and Menthol White exterior personalisation pack at £15,940. Specification featured in advertisement is model dependent. For full specification and pricing details visit peugeot.co.uk or contact your local Peugeot Dealer. Information correct at time of going to press.

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PODCAST

J.J.'S USED UNIVERSE

Recent podcasts include an interview with *The Force Awakens* director, J.J. Abrams, who described working on the film as a "holographic experience. Everything is built on the movies that came before."

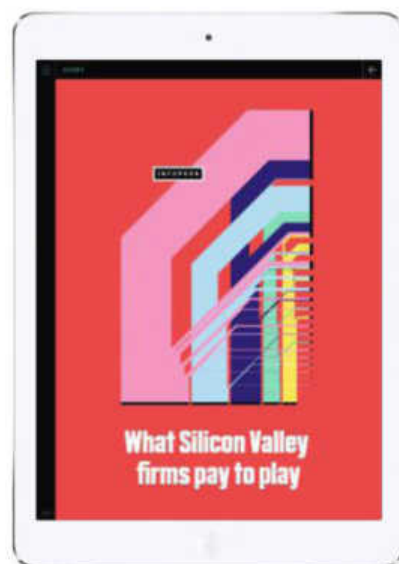
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APPLE NEWS

SPENDING WILL BE TOO EASY

The best of WIRED on your device every day. Stories include this piece on the dangers of frictionless finance.



TABLET EDITION

GOOGLE'S SEARCH FOR RESULTS

WIRED's tablet edition is the perfect place to explore our detailed infographics. This one, from 01.16, illustrates how much big Silicon Valley players spend lobbying to influence US policies. The highest roller? Google, in an effort to affect advertising regulations. wired.co.uk/subscriptions









INSTAGRAM

INSPIRING URBAN IMAGES

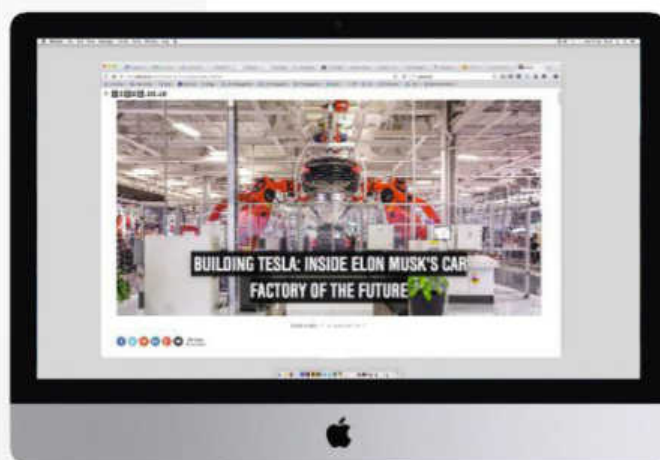
One of our most-liked images on *Instagram* last month was this shot of the Bedford Garden residential complex in Hong Kong by photographer Peter Stewart. It is part of his "Stacked" series, which explores the urban environment and architecture of Chinese public housing. For more inspiring images, updated daily, follow [@wireduk](https://www.instagram.com/wireduk) on *Instagram*.

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INSIDE TESLA'S CAR FACTORY

WIRED.co.uk editor Michael Rundle toured the Tesla Factory in Fremont, California, for a report on what the electric car maker has planned beyond the battery. "Tesla is moving aggressively to make its cars as autonomous as possible," he writes. "Even before legislation or consumers have caught up to the idea of vehicles driving themselves."

FACEBOOK

LET THE WARS BEGIN! (AGAIN)

Most shared on the WIRED Facebook page of late? Not the return of *Star Wars*, but *Robot Wars*... Sign up to [WiredUK](https://www.facebook.com/WiredUK)

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OLIVIA SOLON

Solon – a WIRED alumna – returns to profile Josh Tetrick, whose food startup, Hampton Creek, has \$120m in backing. “He’s taken vegan food and is giving it mass appeal,” she says. “Tetrick and his team are masters of storytelling. That’s how they’ll succeed.”



CALEB HARPER

The director of MIT’s Open Agriculture Initiative writes about how technology will transform food production. “Agriculture is one of the very last industries to move into the age of networked economy,” he says. “It’s time to spread out the data.”



BETH BUELOW

Buelow, author of *The Introvert Entrepreneur*, writes in Ideas Bank on balancing intro- and extrovert tendencies in business. “The success of the ‘ambivert’ affirms the introvert tendency to listen, while challenging us to speak up on behalf of our big idea,” she says.



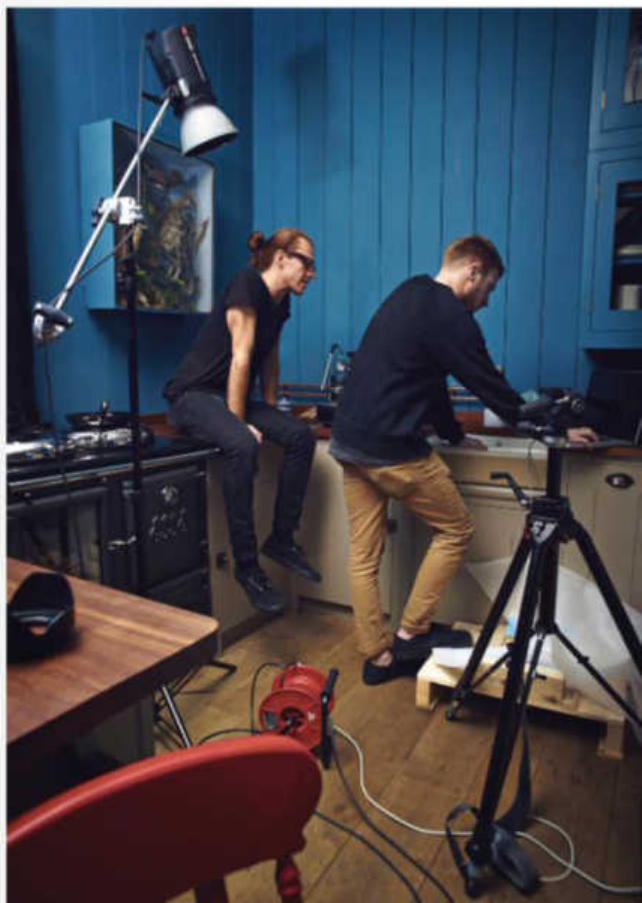
GIACOMO GAMBINERI

Our WIRED Index illustrator branches out into the Gear section for our food special. “I wanted to show that eating is just part of the fun you can have in a kitchen,” he says. “We decorated the blackboard fridge in one take – drawing like that kept it fresh and enjoyable.”



ANDREW HETHERINGTON

Hetherington photographs James McGibney, a former Marine turned cyber vigilante. “He suggested we meet at Battery Mendell – an old military fort in San Francisco, which seemed a good match,” he says. “McGibney’s certainly not shy – useful in his line of business.”



KITCHENS OF DISTINCTION

Photographer Mitch Payne (*above, right*) went on location to the British Standard kitchen showroom in London for our Gear special: “Photographing a lot of products in a relatively small space was a challenge, but the colours and graphic nature of the kitchen units made it so much easier to compose the shots. I’m not a keen cook, but this shoot convinced me to get involved a little more.”



NOMA AND THE ART OF FOOD

Marco Grizelj and Kristian Krän – working as photographic studio AORTA – captured the Noma team, as well as their spectacular cookery, for our food special. “The idea with the food was to create surreal worlds around their dishes,” says Grizelj. “René Redzepi and his team are explorers in the sense of taste – we tried to convey their skill and total dedication with our portraits.”

To paraphrase Marc Andreessen, software is eating the world of eating. Finally, after decades of obesity-inducing, greenhouse-gas-boosting, nutrition-depleting dominance by Big Food, the western diet is being boldly reimagined by a surge of startup innovators. From bioengineered steak to cow-free milk, tomorrow's menu is being created with a new toolkit of precision agriculture, data-optimised science and the obsessive excitement of chefs radically reinventing their craft. And we at WIRED can't wait to tuck in.

This month, we've put together an issue devoted to the future of food, showcasing the vast range of nourishing thinking behind some amazing startups, restaurants and research projects that are transforming what we eat. Partly, it's a movement born of treating nutrition as a coding challenge: the more we learn about plant molecules, the greater the

FROM THE EDITOR

chances of combining them into the ultimate in delicious non-meat burgers. But it's also about rethinking how we source and cook what our bodies most need – whether flavour-encapsulating new freeze-drying techniques or the use of cheap sensors and data analytics to optimise farm yields.

Just visit California to see how far the tech community has embraced the opportunity. You'll meet coders powered only by Soylent, a "modular ingredient" meal-substitute drink that we've been writing about (although, pointedly, not consuming) since 2013. You'll hear investors talking up Impossible Foods, which has raised more than \$108 million (£72m) from the likes of Bill Gates and Li Ka-shing to produce plant-based meat and cheese substitutes – even before launching its first product. On a trip to San Francisco last August, I dropped into Hampton Creek, a startup most famous for its eggless mayonnaise substitute, to sample its dairy-free omelette and cholesterol-free cookies (pretty tasty, actually). It has already raised \$120 million for its mission "to make food healthier for everyone, everywhere". Not everyone, alas, has been supportive: the powerful egg lobby in the US was recently found to have used dirty tricks to keep Hampton Creek's products out of American shops. Guess it must be doing something right.

We put Noma's René Redzepi on the cover not just because we wanted to secure a hard-to-get table at his Copenhagen restaurant, frequently voted the world's best. What really excited us was the obsession with flavour innovation that suffuses Noma's R&D lab and inspires every delicious dish on its two-Michelin-starred menu. We need heroes such as Redzepi to help us radically rethink nutrition in a world due to grow, according to UN estimates, to 9.6 billion people by 2050. And that means finding tasty replacements that can scale to replace the livestock currently responsible for 14.5 per cent of greenhouse-gas emissions – even if that does mean a dinner of sautéed insects and bean-paste fermented with fungi. Bon appétit.

Left: Lettuce grown in Caleb Harper's Open Agriculture Initiative at the MIT Media Lab (see p112)



DMA MAGAZINE OF THE YEAR 2015 • DMA COVER OF THE YEAR 2015 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2015 • DMA MAGAZINE OF THE YEAR 2014 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2013 • PPA MEDIA BRAND OF THE YEAR, CONSUMER 2013 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2012 • DMA EDITOR OF THE YEAR 2012 • BSME EDITOR OF THE YEAR, SPECIAL INTEREST 2012 • D&AD AWARD: COVERS 2012 • DMA EDITOR OF THE YEAR 2011 • DMA MAGAZINE OF THE YEAR 2011 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2011 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2011 • D&AD AWARD: ENTIRE MAGAZINE 2011 • D&AD AWARD: COVERS 2010 • MAGGIES TECHNOLOGY COVER 2010 • PPA DESIGNER OF THE YEAR, CONSUMER 2010 • BSME LAUNCH OF THE YEAR 2009



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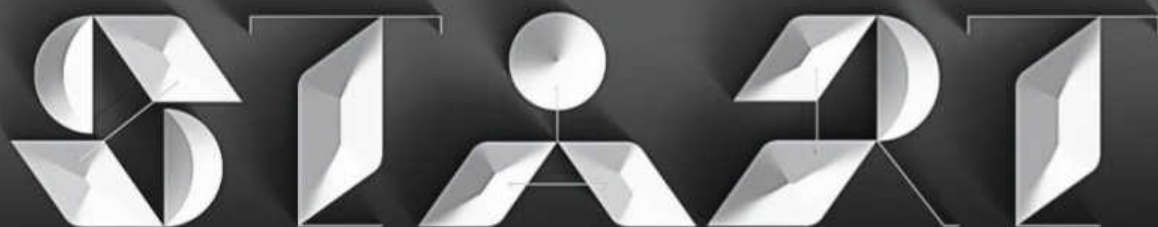
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PAKISTAN'S ROGUE GLACIER

These satellite images show the flow of the Baltoro Glacier in the Karakoram mountain range in Pakistan. Snow is shown as cyan, ice is pale blue, the bare terrain is a muddy brown. The branching formation in the centre of each image is the glacier's ice tongue, brown with rocky debris.

The snapshots come from Nasa's *Landsat* satellite, which produces "false colour" images by measuring wavelengths of light invisible to the human eye. "For glacier analysts this is extremely useful," says Frank Paul, senior researcher at the University of Zurich, who put together the images. "These composites show clouds in a different colour to snow."

Unlike other glaciers around the world, these are not receding, a phenomenon known as the "Karakoram Anomaly". To observe this, Paul turned *Landsat* images from 1990 to 2013 into an animated gif, which revealed some glaciers retreating over short periods, others stationary and some surging.

"This confirms the anomaly in climatic terms," says Paul. "As for the surging – we have no clue why they are doing it." **RM the-cryosphere.**
net/9/2201/2015/tc-9-2201-2015.html

1997

2004

2013



Digital extra!

Download the WIRED app to see more *Landsat* images

INSECT BITES

New York-based Bitty is betting on its cricket cookies overcoming the yuck factor

014 / START / EDIBLE ENTOMOLOGY



The cookie in Leslie Ziegler's hand contains eight protein-rich crickets, thanks to Bitty Foods' patented mix of cassava, coconut and powdered cricket, intended as a replacement for regular flour. Each cup of Bitty's flour contains 28g of protein – around double that of wheat equivalents. So far, so good – but then there's that whole "eating insects" thing... "Eighty per cent of the world's population eats insects," explains Ziegler, who co-founded Bitty with former digital-media exec Megan Miller.

"We want to get the other 20 per cent over the visual barrier."

Bitty buys its insects from US and Canadian cricket farms, which grow them from eggs until they are ready to be "harvested" – a process lasting six weeks. "It's very humane," says Ziegler. "Just put them in the freezer for ten minutes and they go to sleep." The insects are boiled to remove toxins, then dry roasted and milled to a fine powder.

Bitty's cookies are \$10 for a pack of 12, but its flour costs \$20 (£13.30) for 566g. The United

Nations Food and Agriculture Organisation recommends insects for their nutritional value and low environmental impact – but at this price, can cricket flour ever become truly mainstream? Ziegler expects costs to drop as demand for crickets rises.

Every aspect of Bitty's cricket product has been designed to reassure nervous shoppers, from the friendly branding to the choice of insect. Will this help westerners overcome their squeamishness? "Many people don't like the idea," admits Ziegler. "But if they can't see it, then it's OK. Who says no to a cookie?" Bug appétit, foodies. **RM** bitty.myshopify.com

Leslie Ziegler holding a Bitty cookie. (Live crickets not included)





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PHOTOGRAPHY: ENRICO SACCHETTI

Above: XENON1T scientists prepare the lab's time projection chamber

ANOTHER DAY AT THE OFFICE IN THE QUEST FOR DARK MATTER

D

DEEP BENEATH THE GRAN

Sasso mountain in central Italy, the world's most sensitive dark-matter detector hangs suspended in a bath of liquid xenon. This is XENON1T, the Gran Sasso National Laboratory's attempt to observe the invisible stuff that is thought to make up 85 per cent of matter in the Universe (see *R&D in this issue*). "We know it's there, but we can't see it," says Elena Aprile, the project's 61-year-old leader. "We hope that a particle will eventually hit a normal atom [inside XENON1T] so we can see the signature."

XENON1T measures the flashes of light and charge released when a presumed dark-matter particle ➤

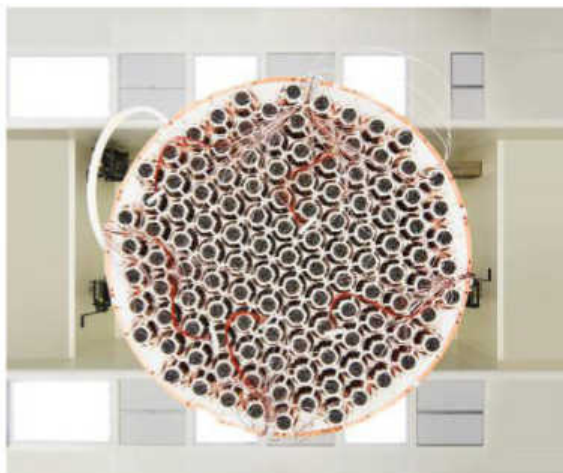
collides with ordinary matter. These collisions are rare – only one a year for every tonne of xenon – so the larger the experiment, the better chance there is of a positive result. The detector is 1m by 1m and contains 3,500kg of xenon, cooled to -95°C to make it a liquid.

XENONIT is expected to deliver its first relevant data this spring, but even if everything goes to plan there may be nothing to report. The experiment is based on the WIMP hypothesis, which suggests that dark matter is made of weakly interacting massive particles. “XENONIT will not see anything if the WIMP hypothesis is wrong,” says Aprile. “These experiments will determine the next decade of effort in this search.” Until then, we’re in the dark. **RM** xenonIt.org



TIME PROJECTION CHAMBER

Scientists build a strong electric current to direct electrons to the top for particle detection: the copper rings shape the field, ensuring electrons drift in the right direction. The pillars are made of Teflon and diamond-polished on the inside for maximum reflectivity.



SENSOR ARRAYS

These sensors detect the light given off when particles are excited: there is an array on the top and bottom, made up of 252 individual sensors. Designed especially for XENONIT, they detect flashes in very deep ultraviolet and are as non-radioactive as possible.

XENON HOUSING

The building on the right houses the systems for cooling and purifying xenon. The tank on the left – a vacuum-insulated double-wall cryostat – holds the xenon, which will be continually filtered during the experiment to remove radioactive contamination.

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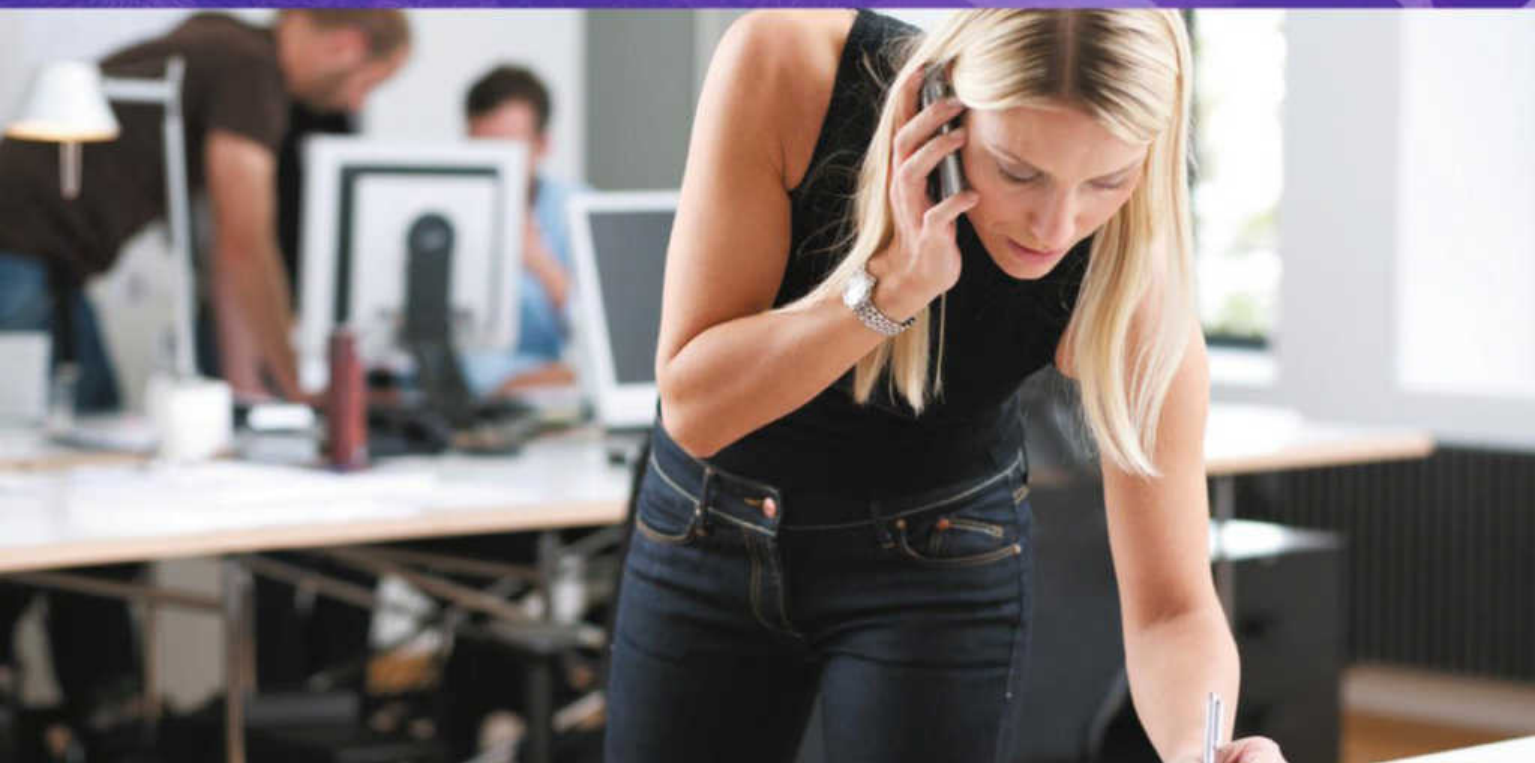


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bt.com/onephone/gomobile



WHERE MOST PEOPLE SEE A SNACK, NORA KHALDI SEES DATA. HER DUBLIN-BASED STARTUP, NURITAS, performs molecular analysis of foodstuffs to search for hidden health benefits, from preventing disease to killing bacteria. "Food is a very complex matrix of data," says Khaldi, 37 (pictured). "We understand how molecules interact with the human body and what their effect is." From its own research, Nuritas has built a database of "bioactive peptides" – protein components that support bodily functions. This subset of molecules, says Khaldi, "has huge health benefits, similar to drugs, but preventative – you can manage certain diseases and prevent them if you eat the right molecules".

To find useful peptides, Nuritas analyses raw ingredients – mainly the cheap, readily available by-products of food production, such as rice husks and pea pods. It uses machine-learning software to match molecules with models of receptors in the human body. If the algorithms point to a suitable candidate, Nuritas proceeds to laboratory tests. "The traditional way of finding a therapeutic molecule usually takes at least seven years and it's a hit-and-miss approach," says Khaldi. "There's a huge need for a new technology that can do it rapidly."

Khaldi, who has a PhD in bioinformatics and molecular evolution, claims to have discovered 21 patent-protected molecules since February 2014, including nine with anti-inflammatory properties, four that she says slow the ageing

process and another that inhibits MRSA – "That one was found in rice." The next step is to take these to market, which she expects to begin in 2017, first in cosmetics then in supplements. "Our product is the ingredient," she says. "We license it to companies that know how to sell it and package it."

Karsten Lemm nuritas.com

MOLECULAR GASTRONOMY

Nora Khaldi's lab research aims to discover a new generation of therapeutic foodstuffs

ATTACK THE DRONES

It was always going to happen: drones are flying into places they shouldn't. But anti-UAV measures can be put in place. WIRED picks out three such systems. RM



DRONESHIELD

This Washington DC-based startup uses acoustic sensors to identify incoming consumer drones from as far away as 1,000 metres. droneshield.com



ANTI-UAV DEFENCE SYSTEM

A radio beam is fired at the drone, disrupting the connection with the controller. It can also alter the focus on the drone's camera. blighter.com



COMPACT LASER WEAPON SYSTEM

Why jam a drone when you can burn a hole in it? Boeing's laser cannon does just that. Tests show it taking down a drone in 15 seconds. boeing.com

MOLECULES ON THE MENU / BUZZ OFF / START / 021



CONFLICT KILLS

The headlines suggest otherwise, but death in war has fallen sharply in recent years

THIS STRING OF MULTI-coloured beads tells the history of war, starting in 1946. Each bead represents a year – the larger the bead, the more recorded battle deaths. The focus on conflicts between states means many violent deaths are excluded – the 1994 Rwandan Genocide, for example – but even so, the overall trend is clear. “The number of people killed in conflict has been declining significantly,” says Henrik Urdal, 43, research professor at the Peace Research Institute Oslo (PRIO), which worked with the Uppsala Conflict Data Project to collate the data. “If you take into account the growth in the world population, the relative risk of dying in war has been going down even more.”

To collect the data, PRIO uses a combination of

surveys, media reports and historical sources. It is by no means an exact science, even in recent conflicts: initial estimates of casualties in Bosnia and Herzegovina, for example, ranged from 60,000 to 360,000 (the International Criminal Tribunal now says there were around 100,000 military and civilian deaths). “The uncertainties are huge,” says Urdal.

Equally uncertain is the reason for the decline. “The main reason for the drop is that some of the regions that have seen the largest battles, particularly East Asia, but also Latin America, are largely free of conflict,” says Urdal. But why does peace settle in some parts of the world and not others? “I’m hesitant to identify a single cause,” says Urdal, “but if you look at the age structure in these areas they have become more mature.” Youth makes a country combustible, as the Arab world demonstrates. “What you see there is being helped by the demographic situation,” says Urdal. [RM www.prio.org](http://www.prio.org)

Total war deaths

Regional breakdown

- Middle East
- Asia
- Africa
- Americas
- Europe

YEAR
RECORDED
DEATHS

1946
299,598

1947
415,311

1965
126,756

1964
91,133

1963
87,418

1962
85,523

1966
124,471

1967
155,574

1968
266,207

1983
251,823

1982
269,443

1981
217,076

1984
268,119

1985
241,743

1986
251,339

2014
101,406

2013
70,451

2012
37,992

2011
22,614

2010
20,371

2009
33,370

2008
49,650

2007
63,538

2006
58,904

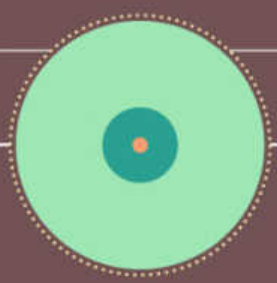
2005
38,652

INFOGRAPHIC: INFOGRAPHIC.LY

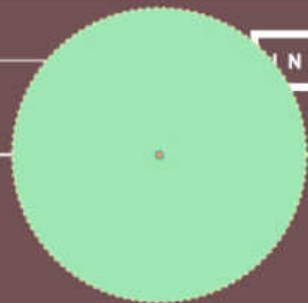
IN F O P O R N



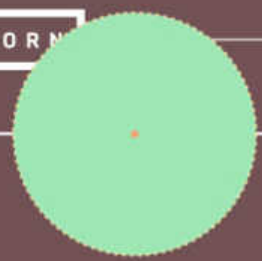
1948
487,262



1949
465,221



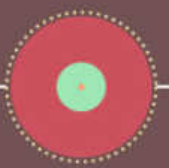
1950
596,013



1951
404,890



1961
173,277



1960
153,880



1959
55,539



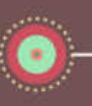
1958
51,740



1957
35,379



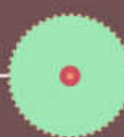
1956
43,547



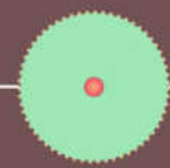
1955
35,260



1954
72,963



1953
103,010



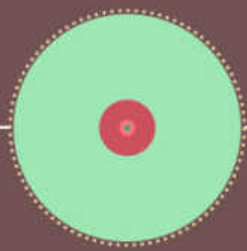
1952
154,097



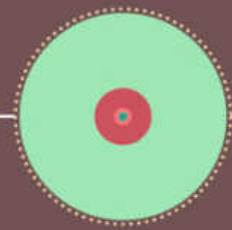
1969
230,683



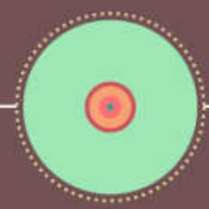
1970
242,440



1971
379,396



1972
319,952



1973
242,046



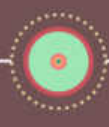
1980
142,228



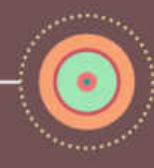
1979
169,221



1978
117,835



1977
60,735



1976
121,213



1975
153,435



1974
280,053



1987
210,557



1988
267,419



1989
86,020



1990
96,532



1991
153,992



1992
101,435



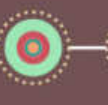
1993
104,131



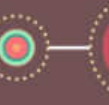
1994
88,686



2004
38,802



2003
35,343



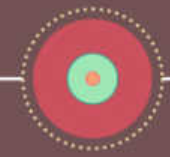
2002
27,594



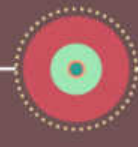
2001
78,703



2000
92,471



1999
134,150



1998
99,840



1997
46,405



1996
56,777



1995
77,145

IT'S TIME DATA MADE GOOD ON ITS PROMISE.

It's time data worked for you and not the other way around.

It's time to transform data from freight into fuel.

To let it power decisions instead of impede them.

It's time to rise up against the scourge of junk data.

To seize what's rightfully yours.

To shape it into something that's no longer a costly burden,
but an always-on, always-available source of insight.

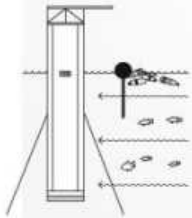
It's time to show your data who's boss.

IT'S TIME FOR VERITAS.

www.veritas.com/en/uk

VERITAS[™]

The Ocean Cleanup's floating barriers catch plastic debris with the help of the sea's currents



BOYAN SLAT WANTS TO HELP THE ocean to clean itself. “Actively fishing for plastic [to remove it] would take 7,900 years, and create emissions,” says the 21-year-old founder and CEO of Delft-based organisation The Ocean Cleanup. “So I thought: why would you go through the ocean when the ocean can go through you?”

Slat's idea is to install floating barriers – secured to the seabed – and let the currents do the work. He believes plastic will build up at the centre of the boom, where it can then be removed by pumps and conveyor belts. Recovered plastic will then be recycled, helping to fund the project.

The goal is to deploy a 100km boom by 2020 in order to clear half of the so-called “Great Pacific Garbage Patch” – a Texas-sized area of plastic junk – within ten years. “It would cost about €350 million [£258m],” Slat says. “It's very cost effective when you're talking about solving a world problem.”

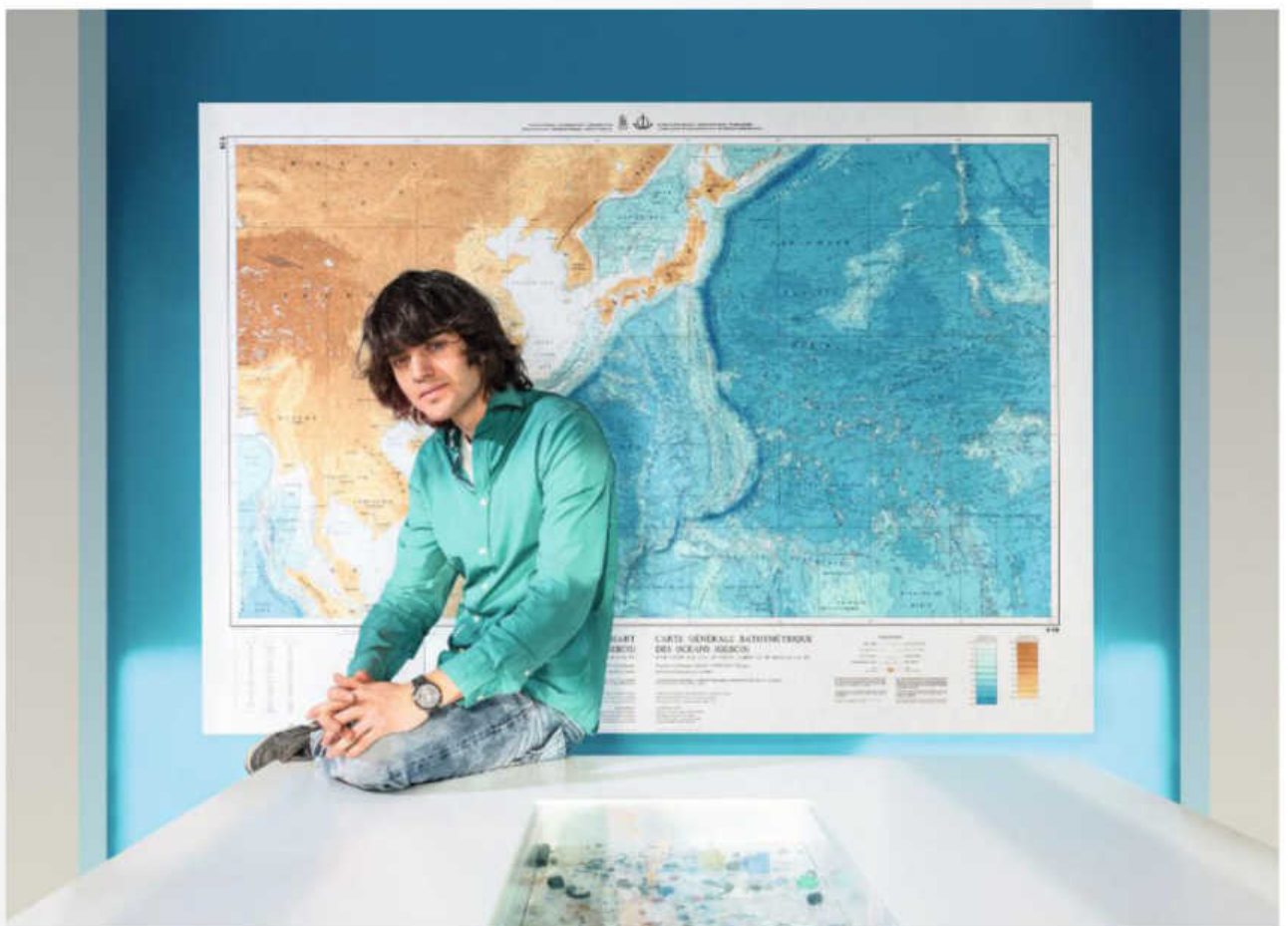
In August 2015, Slat led an expedition of 30 vessels to better understand how much plastic is in the patch. After one month, the researchers concluded that there is far more than expected, most of it in large chunks. That's good on the one hand, because large chunks are easier to scoop up. But, as the plastic degrades, many more microplastic particles are going to end up in the seas – and in the food chain.

So Slat is speeding up his schedule. After crowdfunding more than \$2.2 million (£1.4m) in September 2014, The Ocean Cleanup will conduct two scale tests in 2016; the first, in the second quarter of the year, will test a 100m barrier 23km off the coast of the Netherlands. The results will affect a 2km barrier near the Japanese island of Tsushima, to be installed in the second half of 2016. The project is expected to last for about two years. “We design something and we test it fast,” Slat says. “It's cheaper and more effective than spending years in front of a computer to find out whether it works or not.” **Gian Volpicelli** theoceancleanup.com

CATCH OF THE DAY: PLASTIC

After crowdfunding \$2.2 million, Boyan Slat is about to embark on a two-year pilot project that could eventually rid the ocean of rubbish

CURRENT THINKING / START / 025



The goal for The Ocean Cleanup, says Boyan Slat, is to clear half of a Texas-sized area of plastic floating in the ocean within ten years

HOW WILL TECHNOLOGY CHANGE THE WAY WE EAT?

REBECCA CHESNEY

FOOD FUTURES LAB, INSTITUTE FOR THE FUTURE

"Technology will change not only the *way* we eat, but *what* we eat. Scientists are using advanced genetic-engineering tools to recreate familiar foods in new ways. In the near future, milk, egg whites and specific flavours will be brewed from yeast – similar to the brewing of beer. As the technology becomes cheaper and more sophisticated, our paradigms for natural, sustainable and safe food will need to expand to accommodate a wider spectrum of choices and dilemmas. The question isn't if these foods will be possible, but when the policies, regulation and eaters catch up with the science." **GV**



026 / START / FUTURE FOOD



CHARLES SPENCE

DEPT. OF EXPERIMENTAL PSYCHOLOGY, UNIVERSITY OF OXFORD

"Technology will continue to distract us while we're eating and drinking, but I'm optimistic that in the years to come it will become an integral part of our food and drink experiences. Everything from using an iPad as 21st-century plateware to using handheld technologies like a musical glass to provide a dash of digital seasoning – that is, providing the right sonic backdrop matched to bring out the best in what we're eating or drinking."



SAM BOMPAS

CO-FOUNDER, BOMPAS & PARR

"Technology will allow us to experience previously unknown, rare and wondrous flavours. We're working with molecular biologists to create 'the steak that time forgot': mammoth meat from a lab environment. It will take a while and there are ethical considerations, but it will culminate in an epic feast where humans will be able to taste flesh that's been extinct for 10,000 years. Technology will allow us to go beyond the paleo diet to taste delicacies from before the dawn of civilization. What foods these morsels be!"



MAUREEN EDMONDSON

PRESIDENT, INSTITUTE OF FOOD SCIENCE AND TECHNOLOGY

"In a digital world we personalise most things, so why not food? First, select a protein source, quantity, nutritional profile, production site, cooking medium, recipe and storage medium. Then determine where and how it will be delivered using an Amazon-style retailer. In contrast, local home-grown, home-processed stores will flourish as a source of solace for those revolted by too much technology associated with the provisions of Mother Nature."



RYAN PANDYA

CO-FOUNDER AND CEO, MUUFRI

"Food was the first technology. Farming, irrigation, cooking – none of these things are natural. But for the most part we've been letting nature turn the 'coarse' knob and we've been turning the 'fine' knob. What happens when we grab control of the coarse knob? The first priority is to get animals out of the food system – they're antiquated now we have better ways of making what they make. I like to imagine that in the future, we'll be able to invent substances like milk that simply had no reason to evolve naturally."



ADRIAN CHEOK

FOUNDER, MIXED REALITY LAB, SINGAPORE

"We are working on technologies that use electromagnetic stimulation to produce tastes and smells without using chemicals. We'll be able to sense and transmit flavours as digital information, so we can have multi-sensory communication experiences – things like sharing a virtual meal with friends and families on the other side of the world, watching a chef on TV and tasting their food, or sharing food pictures on *Instagram* with the flavour added."



This cloud redefines winning.

The Microsoft Cloud gives Special Olympics instant access to key performance and health data for every athlete, no matter where they are. Microsoft Azure and Office 365 help streamline the management of 94,000 events across 170 countries each year. So the focus can be on changing the lives of athletes, and that's the true victory.

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 **Microsoft Cloud**

PHONE UNLOCKED

Rand Hindi's *Snips* wants to humanise your smartphone interactions with AI

R



AND HINDI WILL SAVE YOU

three seconds when your friend *WhatsApps* you the address for tonight's party. Sure, connecting that address to *Uber* or *Citymapper* won't change the world. But it's an example of how his AI app *Snips* is aiming to make your phone more human. "We're putting artificial intelligence in your phone, so it can adapt to your situation," says Paris-based Hindi, 30, the company's co-founder and CEO.

With *Snips* on your device, the multi-stage process of looking up an address – jumping from an email via the home screen to copy-and-paste text into *Citymapper* or *Google Maps* – is reduced to a single tap. The app's natural-language processing and machine-learning software identifies an address, guesses what you are going to do and provides a pre-filled solution. "*Snips* aggregates your data and links that to the apps that are relevant," says Hindi. "The point of the product is to learn so much about you and what you do, that it does it for you."

But apps are just the start. *Snips* learns your habits and preferences by applying more than 20 algorithms to your messages, calendar, contact list and background location. It's a daunting collection of private material, but Hindi, who has a PhD in bioinformatics, assures WIRED its data is safe: the 27-person company, which has raised \$6.3 million (£4m) in seed funding conducts almost all its analysis on your device, and sends none of your data to its servers. "A company that says they need your data is lying," he says. "Or has no clue how to build technology."

Hindi looks forward to a world where a range of intelligent devices will anticipate our commands. Far from undermining our freedom, he believes, this technology is safeguarding it. "I don't want everything I do to be a consequence of a device," he says. "If you put an AI in every device, you can start, as a human, to not pay attention to it any more." **RM *snips.ai***

028 / START / AI APP

WIRED	TIRED	EXPIRED
SREUA	DCMA	RIPA
Bricky	Earlybird	Unsharp mask
Homebrew CRISPR	Bellybutton sourdough	Amateur fecal donation
Millicorns	Unicorns	Decacorns
Cancer pigeons	Combat dolphins	Truffle pigs



This cloud stands up to any storm.

Microsoft Azure scales to enable AccuWeather to respond to 10 billion requests for crucial weather data per day. This cloud rises to the challenge when the weather is at its worst.

This is the Microsoft Cloud.

learn more at microsoftcloud.com

 Microsoft Cloud

WHAT'S INSIDE

E-CIG JUICE

WATER

Many "vape juice" flavours include good old H₂O. A reservoir for liquid and a heating element are the basic components of e-cigarette devices. A wicking material such as cotton pulls the liquid towards a metal coil, where heat turns it into droplets that are tiny enough to inhale.

VEGETABLE GLYCERIN

You've probably consumed this sugar alcohol in food as a low-glycemic sweetener, a preservative, or a texture enhancer that boosts thickness. (It's also an ingredient in moisturisers.)

PROPYLENE GLYCOL

A tasteless, odourless, colourless alcohol used in antifreeze. Although it's considered safe for topical use and consumption, it's also an active ingredient in many fog-machine juices, which can act as allergens and cause eye and airway irritation. It can also cause headaches, dizziness and drowsiness.

FLAVOURING

The names of e-cig flavours are amazing: Unicorn Milk; Krispy Krack Doughnut; Pony on Acid! Manufacturers usually don't reveal ingredients on the grounds that they're "trade secrets". Many assert that their flavourings are food-grade and safe.

NICOTINE

In its inhaled particulate form, nicotine itself is pretty safe – unless you're a child or a gestating foetus in a vaper. But in liquid form, even tiny amounts that are ingested or make contact with skin can induce vomiting, seizures and even death. Wear gloves when you refill.
Blanca Myers



EARLY ADOPTERS

WHAT'S EXCITING...

ZOE BURGESS

Head of research and development
The Drink Factory



"I've rediscovered **BUG** at the BFI Southbank, which showcases some of the most exciting music videos from established and up-and-coming directors, hosted by Adam Buxton. It's a great way to see how the use of new technology is impacting music-video production."

WHAT'S EXCITING...

PAUL MILLER

Partner
Bethnal Green Ventures



"The Master

Algorithm by Pedro Domingos really got me thinking. It's a great intro to machine-learning techniques. What excites me is the potential to use machine learning and AI to improve things such as diagnostics, education and energy use."

WHAT'S EXCITING...

ANA ANDJELIC

SVP, global strategy director
Havas LuxHub



"I am planning to use **UberEvents** for the office party, so we can send guests home in bulk, without them worrying about cost. I've created a code that can be used for multiple simultaneous rides. More proof of how Uber is evolving the way the world moves around." **RM**



This cloud redefines winning.

The Microsoft Cloud gives Special Olympics instant access to key performance and health data for every athlete, no matter where they are. Microsoft Azure and Office 365 help streamline the management of 94,000 events across 170 countries each year. So the focus can be on changing the lives of athletes, and that's the true victory.

This is the Microsoft Cloud.

learn more at microsoftcloud.com

 **Microsoft Cloud**



T

HIS SUPERCRANE IS STRONG ENOUGH to lift entire sections of a bridge, so they don't have to be assembled in the air. The Left Coast Lifter sits atop a 117-metre barge powered by three diesel generators, and it can lift 1,750 tonnes. It is being used to build the 4,881-metre Tappan Zee Bridge in New York state, putting prefabricated sections, including 106-metre pieces

of steel, into place. "It takes a project of this grand scale to use a crane like this," says Ron Crockett, who commissioned the crane's construction. Not only because its size prevents it from being used in most locations, but also because a smaller-scale project might not benefit economically. "The project needs to be designed around the crane, not the other way around."

The floating crane's movements are planned months in advance, down to the finest details. All eight anchors are positioned so that they can be used for multiple operations. "With the anchoring system you can turn the entire crane," says Crockett. "The anchor winches are electronically controlled by a master console, so you can turn this crane just about any way you want." The crane can be pulled into different positions by relaxing and tightening anchor lines. Then a GPS system tracks the precise location of the crane and the load, so that each manoeuvre can be executed exactly.

What about the name – isn't New York on the east coast? The Left Coast Lifter was built for the San Francisco Bay Bridge project. "There is no other crane of this size qualified to work in US waters," says Crockett, who was the technical director on the Bay Bridge project. **Sophia Epstein**

TAKE IT TO THE BRIDGE (WITH GPS)

A giant crane that can lift 12 Statues of Liberty is assembling a New York bridge



Nicknamed "I Lift NY", the crane raises a pair of precast pile caps – each of which weighs 550 tonnes

PHOTOGRAPHY: NEW YORK STATE THRUWAY AUTHORITY

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DEEP INSIDE THE LONDON DISTILLERY, IN Battersea, the air is filled with a deep whir and a tang reminiscent of stewed meat. Two workers stir six large tanks, moving a paddle through a brew of hot water, barley and yeast. This brown broth, known as wort, is the product of the mashing process, in which the water, barley and yeast mix is heated in a tank to convert the starch in the grain into sugar. The wort is being readied to pass through Matilda, the bell-shaped still

dominating the room. Alcohol boils at a much lower temperature than water: Matilda's steel and copper tubes are designed to make spirits condense and drip into a separate tank. From here, the spirit is transferred into casks. It will take three years and two weeks more for the spirit to age and transcend into its final stage – pure London whisky.

The London Distillery's co-founder Darren Rook explains that the last establishment to produce whisky in London closed “over a century ago, in 1903”. In 2011, Rook and co-founder Nick Taylor turned to crowdfunding platform Crowdfunder to kick-start their project. They raised £258,000, which they used to establish the business in 2012. “We ordered the equipment from Germany, but the rest comes from England,” he says. “From heritage barley to the honey we use in gin, which is sourced from hives all around London.”

The whisky ages in barrels made by a Yorkshire-based cooper; but the quality and temperature of the brew are constantly checked using digital probes and sensors. Rook says he is in the process of scaling up the production soon. “Every mash can fill a hogshead barrel [245 litres],” he says. “We aim for 1,400 litres of whisky a month.” WIRED shows you what's brewing in The London Distillery. [GV londondistillery.com](http://GV.londondistillery.com)



RENEWING THE CITY'S SPIRITS

Our series on tools focuses on The London Distillery, making the first whisky in the capital after a century

BOTTLE FILLER

To qualify as whisky, the journey from barley to bottle must take at least three years and two weeks — but the last step is

the quickest. Once the tank is filled with amber liquor, the bottle filler can pump a half-litre into a bottle in ten seconds.

MATILDA

The gleaming whisky still is named after Rook's grandmother. Inside, barley, water and yeast mash are boiled, and the alcoholic vapour condensed, collected and boiled for a second time. It is this second distillation that produces the whisky. Matilda's upper section is copper, which removes any distasteful, unwanted sulphur from the spirit.

TOOLKIT



TANK

Hot water, barley and yeast are whipped by rotating blades inside the stainless-steel tanks. During the four-hour process, the yeast feasts on barley sugar, converting it into alcohol as a by-product. “At the end of this process, we re-bag the spent barley for a farmer – it's still good for use as feed for his cows,” explains Rook.



SACCHAROMETER

The apparatus floating in this measuring tube is a saccharometer, a brewer's tool used to gauge the mash's sugar level (the optimal level is 10.60g-10.65g per cm³). As the sugars reduce, the mash density changes, causing the weighted saccharometer to sink lower.

APPS OF THE MONTH



◀ WIRED

UMAKE

Design your next 3D-printed car using this sketching app. Draft an outline on uMake, then manipulate the design to create a 3D model. Ideal for designers who want to prototype and amateurs who want to play around. *iOS, free* umake.xyz



SHOOTY SKIES

Fly like an eagle and fight like an octopus in this erratic shooting game. Expect bright colours and blocky features to whizz by as you aim a stream of bullets in this retro arcade scrolling shooter. *Android, iOS, free* shootyskies.com



SOON

This list app with a twist means you'll never be lacking things to do. Soon lets you curate the films, books and places you've been meaning to watch, read and visit. Its trending section is great for inspiration. *iOS, free* soonforever.co



COSMIC WATCH

Explore the Earth, solar system and constellations in real time with the Cosmic Watch app. It includes an eclipse mapper and a tool for adjusting telescopes. *Android, iOS, £3.35 (Android), £2.99 (iOS)* cosmic-watch.com



DREAMLAB

Donate your spare mobile processing power to the fight against cancer with this app, which downloads genetic sequencing profiles and processes them during the night when phones aren't in use. *Android, free* vodafone.com.au/dreamlab



◀ WEIRD

PERCH

If you've wondered what goes on in your house when you're not in it, Perch is the answer. Connect your phone with a strategically placed laptop, tablet or phone camera and watch live from anywhere. *Android, free* getperch.com
Cara McGoogan

036 / START / APPS / DÉJÀ VU / FOOD WASTE

OUR TIPS FOR 2017'S HOTTEST STARTUPS

Silicon Valley is always producing game-changing ideas – but sometimes, it's not so innovative. Uber's UberHop ride-sharing taking passengers along a defined route? That's a bus. Beats One? Try radio. Oh, and Amazon has opened its first bookshop... WIRED guesses at the next big things. OF-W



AIRBNB HOTELS

Just think: stay in any city, in your own room, with your own fridge. No auditioning for unwelcoming hosts, or dodgy bed linen. And check-in? Easy! Arrive any time – there's a whole desk just to welcome you.



OCULUS PHYSICAL REALITY

Want to experience an immersive 360° world of virtual reality, but with your friends in the same space? Come down to a live venue for an HD, low-latency experience. No motion sickness. No DLC. And you should try the touch interface.



SPOTIFY PREMIUM MIXTAPES

Find streaming too ephemeral? Keep all your favourite songs in one place with Spotify's custom-curated vinyl records. Always available offline, with no buffering. Better yet, they're totally ad-free.

NO CHARD LEFT BEHIND

How tech is taking a bite out of 1.3bn tonnes of uneaten food

CHEF'S KITCHENS

Winnow cuts kitchen waste by tracking what chefs throw away. Recorded on a touchscreen, the data enables behavioural change. The firm claims to have saved 150 restaurants nearly £2 million. winnowsolutions.com

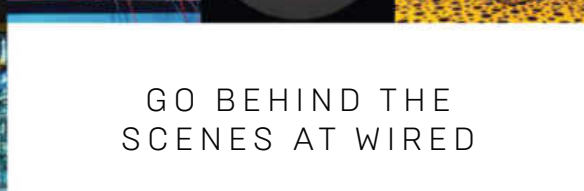
FIGURES FROM THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO) suggest that one third of all the food grown – 1.3 billion tonnes – never gets eaten. Instead, it rots in landfills, spewing out methane, a greenhouse gas that contributes to climate change. “We are directly extracting – then wasting – natural resources,” says Camelia Bucatariu, policy consultant for the FAO.

With the UN expecting the global population to reach 9.15 billion by 2050, the pressure is on to make the most of what we grow. “Food waste is becoming a priority,” says Bucatariu. The path from farm to fork is broken. That’s where startups come in to fix the food chain. **Chris Stokel-Walker**





DAILY UPDATES FROM
THE WIRED TEAM





M

MAVERICKS' BIG-WAVE FORECASTER

Mark Sponsler surfs reams of data to ensure roller contests don't disappoint

ARK SPONSLER IS SURROUNDED by eight computers as he studies a spinning blob over the North Pacific on one of the screens. He's looking for a storm; one big enough to send a massive swell barrelling towards the California coast. Ideally, that swell will slam into an underwater ridge about one kilometre off Pillar Point, creating 20-metre-high waves. And a handful of lunatics will descend on Northern California to surf them.

The founder of Stormsurf, Sponsler is responsible for collecting the data needed to green-light the Titans of Mavericks big-wave

competition held between November and March at the notorious break. The contest doesn't happen every year; waves must be more than 12 metres high and surfable. That's where Sponsler comes in.

A former software engineer for Nasa's shuttle programme – and a keen surfer himself – 58-year-old Sponsler has been designing computerised wave models since the early days of the internet. But he says that for important events like this, he crunches the numbers by hand using swell-decay tables – charts that estimate the rate at which swells steadily lose their power and momentum as they travel through the ocean – and his own algebraic equations. Then, he confirms his forecasts via the Jason-2 satellite, which can measure sea height to within a few centimetres.

After 20 years of forecasting (and surfing) Mavericks, Sponsler says he can paddle out right before the sweet spot of a swell and “taste it like fine wine. You learn to pick out the very best barrel in a batch of a whole year's harvest.”

The super El Niño of 2015 is almost guaranteed to produce a number of qualifying swells, Sponsler says, but that's no reason to stop running the numbers: “There's nothing worse than sitting here, looking at all the data, going, ‘Where's my friggin' swell?’” he says. “That's my nightmare.” Our nightmare? Riding a 12-metre wave. **Dan Steiner**

Mark Sponsler



Cognitive inventory is here.

When a product is 'hot', how do you keep the right styles and sizes in stock and ready for customers to buy? To help reduce lost sales, major retailers can use cognitive technology to look at structured data like sales reports and unstructured data like tweets and weather feeds. When your business thinks, you can outthink out-of-stock.

outthink

trends

ibm.com/outthink/uk



IDEAS BANK

BETH BUELOW

Introverts beat extroverts. But ambiverts win

If you sell things for a living, you probably spend a lot of time focusing on what to say to your prospective clients. How you pitch, what you present, where in the conversation you attempt to close the deal. This is especially true if you're a sales-adverse introvert: you might believe you need the gift of gab in order to succeed. But in fact, it looks like that success belongs to those who know when to open their ears and when to open their mouth. They can introvert and extrovert – as verbs – in order to connect with the other person.

These people who find that happy Goldilocks-style middle ground – an approach that's not too hot, not too cold, but just right – are called ambiverts. These are people who fall in the middle of the introvert-extrovert spectrum. They feel an equal comfort with and desire for socialising and solitude. Recent research, conducted by Adam Grant (my Ideas Bank colleague)

of Wharton School of the University of Pennsylvania, supports an integrated approach, one that demonstrates the value of drawing on both your introvert (listening) and extrovert (talking) energies. Grant administered a personality survey to 340 call-centre employees and tracked their sales records for three months. He began with the hypothesis that extroverts, rather than outperforming their more introverted counterparts, would report less-than-stellar results. He was right: those who fell more in the middle – the ambiverts – outproduced people who fell on the extremes of the introvert-extrovert spectrum. The ambiverts earned 24 per cent more in sales than the introverts, and 32 per cent more than the extroverts. "Because they naturally engage in a flexible pattern of talking and listening, ambiverts are more inclined to listen to customers' interests and less vulnerable to appearing excited or overconfident," said Grant.

How is this information useful to introvert entrepreneurs? First, it shows that introverts already have a head start when it comes to sales. The typical buyer is more likely to be turned off by the salesperson who talks too much than by someone who listens too much. And remember: in the research, the introverts outperformed the extroverts. Since we tend not to respond to someone talking us into submission, introverts

are likely to use a more balanced talking-listening approach when we're the ones making the pitch.

Second, most of us flirt with ambivert tendencies rather than being on the extremes. We shapeshift a bit depending on the situation, even though we still have a core energy that leans introverted or extroverted. If you're an introvert, that means you probably just have to sharpen a latent extroverted skill you already have, rather than starting from zero. We often have a healthy curiosity, so it might simply be a matter of asking the questions that come to mind in the moment, rather than keeping them to ourselves or trying to follow up later.

And finally, it helps us to release the expectation that one must be outgoing and be able to make small talk about everything under the Sun to be a good salesperson. The success of ambiverts affirms the introvert tendency to listen, while challenging us to speak up on behalf of our solution or big idea.

There's a call for both activities, in moderation. And when it comes to sales, we'd all do well to heed the words of Epictetus: "We have two ears and one mouth so that we can listen twice as much as we speak."



Beth Buelow
is the author of
*The Introvert
Entrepreneur*
(Virgin Books)



KAT ARNEY

We don't need DIY gene tests to tell us we're mutants

A

ngelina Jolie Pitt has probably done more to raise the public profile of genetics than any other person. Her announcement that she carries an abnormal version of the BRCA1 gene responsible for the cancer that killed her mother, followed by surgery to remove her breasts and ovaries, was a bold statement of belief in the power of genetic testing to predict disease.

Jolie Pitt's analysis, we can assume, was delivered by her doctor alongside appropriate genetic counselling in a healthcare setting. But this isn't the only way to take a look inside your genes. For £125 you can fill a tube with saliva, pop it in the post to 23andMe and receive a genetic treasure trove.

But while a growing number of people are getting their genomes done the DIY way, there are some big issues to be aware of. I'm not talking about the challenges of privacy and data ownership – although those are more than a little terrifying. I mean the fundamental underlying biology.

Decades of media coverage about how our genes work has driven home the concept that genes are “for” something, be it baby-blue eyes, breast cancer or a propensity to a punch-up. But examples like BRCA1 – whereby a single genetic mistake hugely increases the risk of a particular disease – are rare. And even carrying the fault isn't a cast-iron guarantee: there's a 60 to 90 per cent chance of breast cancer, and around 50/50 odds on ovarian cancer.

Our genes don't act in isolation. Every letter of our DNA is a tiny part

of our bigger human story. In any two human genomes there are millions of differences, and their effects are interdependent. Sometimes the effect of a particular gene fault might be cancelled out or enhanced by other variations in the genome. Or it might be influenced by random wobbles in our biochemistry, or influences from the environment. Sorting the genetic wheat from the chaff is a tough task, and one that researchers are only just embarking on in any serious way.

We're all have a smattering of potentially dangerous or even deadly gene faults, as well as millions of random and inconsequential differences peppered throughout our genome. But you might never even know about it until you start ferreting around in your DNA. And once that Pandora's box is open, what are you going to do about it?



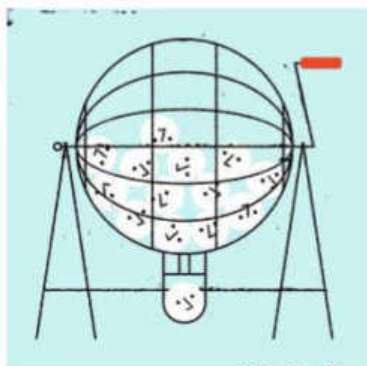
Kat Arney is a UK-based science writer and broadcaster. She is the author of *Herd of Hemingway's Cats: Understanding How Our Genes Work* (Bloomsbury)

I've never had my genome analysed, but I know people who have. Although they found their results interesting, there was little significant information that they couldn't have figured out from their family history. And the health advice to reduce the risks of diseases as diverse as Alzheimer's and cancer comes down to the usual boring stuff about not smoking, taking plenty of exercise and watching one's weight.

DIY gene testing may be a useful starting point to get people engaging with their genomes – an increasingly urgent need as medicine becomes ever more tailored to our individual genetic quirks. But its runes should be read cautiously, at least until we understand a lot more about how the genome works.

To put it simply: everyone's a little bit mutant. We just don't know how much it matters.





RICHARD NISBETT

Interview over: first impressions don't count



Richard Nisbett is a professor of social psychology at the University of Michigan and author of *Mindware: Tools for Smart Thinking* (Allen Lane)

C

onsider the following story. A football coach in the US had heard of a great player at a local school. The player had powered his team to a strong win/loss record and his coaches thought he was one of the most talented players they had seen in some time. But the coach observed the player at a practice game and was unimpressed; the

player made several errors and was not in full control of the ball. The coach told his colleagues that it wouldn't be worthwhile to try to recruit the player.

Doesn't sound quite sensible, does it? Most sports fans would think that was a pretty foolish call. Athletic performance is much too variable across occasions to base an important judgement on such a small sample. But now consider this problem: an employer gets an application from a junior executive who has to leave his company because his partner has to move city for work. The applicant has an excellent college record, had been rapidly promoted in his current firm and has strong references from his present boss. But the prospective employer interviewed the applicant and was unimpressed. He didn't seem to be terribly bright and his responses to hypothetical management situations were somewhat uninspired. The employer tells his colleagues that it wouldn't be worthwhile to try recruiting the applicant.

I find that most people regard this as a reasonable sort of decision. But it isn't. Countless studies show that the unstructured 30-minute interview is almost worthless as a predictor of school or college performance, effectiveness as a physician or corporation executive, success in army-officer training or any other long-term performance criterion. The correlations run in the vicinity of 0.10, which isn't much better than a flip of the coin. But in each of these cases, predictions based on a summary of information in the folder – grade-point average, ability-test scores, previous job performance, letters of recommendation – commonly are correlated 0.4 to 0.5 with performance. The difference between 0.52 and 0.65 could easily be the difference between success for an enterprise and its failure.

But we might as well interview anyway, right? Wrong. We are incapable of treating interview data as having little or no value. There's lots of psychological theory and data backing up this claim. The upshot is that my recommendation is not to interview at all – or to devise with the help of an expert a highly structured interview in which every can-

didate is asked exactly the same questions. Such interviews actually do have some predictive validity and are worth adding into the stew of information used to make a choice.

Why do we get the athletic problem right but the employment one wrong? Because, unlike athletic performance, we haven't seen hundreds of candidates in interviews of a particular type and seen how well performance in the interview corresponds to performance over the long haul in the setting we're concerned about. We haven't seen how common it is that the guy who looks like a dunce in the interview often turns out to be a whizz on the job and the guy who aced the interview turns out to be a dud. Nor do we have systematic observations that could tell us how common it is that the person with the more impressive folder is actually more likely to turn in a good performance than someone with a weaker record.

The only way to see that the interview isn't going to be worth much is to be able to apply the law of large numbers. This principle specifies that as a sample size gets larger you get closer to true population values, such as mean or proportion. This prompts the recognition that an interview represents a very small sample of behaviour whereas the contents of the folder summarise a lot of accumulated behaviour.

How can we make it more likely that we'll understand the relevance of the law of large numbers for problems where the data is hard to code or difficult to examine systematically, such as a one-shot observation of a given event or behaviours reflecting personality traits such as friendliness or honesty? One tip: think of all evidence about an event of a given kind as a sample from a population of similar events. That can prompt the realisation that we don't really have all that much evidence. Even better, it can alert us to the possibility that our evidence may be biased in some way.

The job interview is not only a tiny sample; it's not even a sample of job behaviour but of something else entirely. Extroverts in general do better in interviews than introverts do, but for many if not most jobs that's not what we're looking for.

To be a great entrepreneur, you need three things: courage, confidence and commitment. The best founders are daredevils who take big risks to bring their ideas into the world. They are self-assured, never doubting themselves even in the face of rejection. And they are obsessed to the point that they will sacrifice almost anything, because starting a company requires complete devotion.

These beliefs are widespread, but they are dead wrong.

Last year, researchers Joseph Raffiee and Jie Feng published a landmark study. Called “Should I Quit My Day Job?: A Hybrid Path to Entrepreneurship”, it tracked a nationally representative group of thousands of US entrepreneurs over 15 years. It revealed that those who started companies on the side while keeping their day jobs were 33 per cent less likely to fail than the ones who went all in.

It may not be a coincidence that Phil Knight spent five years selling running shoes before leaving his full-time accounting job to start Nike. That Steve Wozniak stuck around at Hewlett-Packard for a year after inventing the Apple computer. Or that Bill Gates spent a year at Harvard after selling his first software program, and Larry Page and Sergey Brin waited two years after building their search engine to leave Stanford and launch Google.

Keeping the day job gives you the time and resources to refine. If you're committed to entrepreneurship, you have to worry about quarterly results. That means putting all your eggs in the basket where they're most likely to hatch quickly. By keeping your day job, you gain a licence to tinker and iterate.

After Sara Blakely dreamed up the idea for footless pantyhose, she held on to her full-time job selling fax machines. Rather than succumbing to the pressure to ship a product immediately, she spent the next two years perfecting her prototype. That prototype – Spanx – made her a self-made billionaire.

Hanging around in your day job also creates more flexibility to pivot. “I gave up my job for this idea,” you think, “so I have to see it through.” If it's just a hobby and it falters, you'll have no qualms about moving on to the next idea.

When Markus Persson was working as a programmer, he built video games in his spare time. If game development was his only source of income, he would

have focused on making his existing creations commercially successful. Instead, he started working on a new game. He posted *Minecraft* unfinished on a gaming portal. He kept his day job for a year before committing full-time. *Minecraft* became the most popular computer game of all time, and he sold it to Microsoft for \$2.5 billion (£1.7bn).

In the research, the founders who kept their day jobs and dipped a toe into entrepreneurial waters were more risk-averse, less self-confident and less committed than their peers who dove in headfirst. According to conventional wisdom, their businesses survived in spite of those traits. But in reality, they



Adam Grant is a professor of psychology at the Wharton School of the University of Pennsylvania and author of *Originals: How Non-Conformists Change the World* (WH Allen)

ADAM GRANT

Entrepreneurs, don't give up your day jobs



succeeded because of their hesitations. Being risk-averse led them to look carefully before leaping in. Self-doubt led them to question their ideas. And wavering commitment motivated them to seek honest feedback about which ideas were really worth pursuing.

Quitting your full-time job to start a company is like proposing marriage on the first date. For every successful startup with a swashbuckler at the helm, there are many more that fail. The most durable businesses are typically started by people who play it safe.

So next time you have a big idea, don't go in all guns blazing. Start it as a hobby and see if it takes off.



PHOTOGRAPHY: LEON CSERNOLAVIK

TUMI WIRED
INNOVATION
IN
TRAVEL
AWARDS

The travel awards

TECHNOLOGY IS TRANSFORMING OUR TRIPS, ENABLING MORE EFFICIENT JOURNEYS AND GREATER LEVELS OF COMFORT AND LUXURY. WIRED AND TUMI AWARD THE INNOVATORS IN TRAVEL

AWARD WINNERS:

BEST TRANSPORT HUB

Kings Cross Station, London

BEST TRAVEL INFLUENCER

A Luxury Travel Blog

BEST IN-FLIGHT EXPERIENCE

Emirates Ice Digital Widescreen

BEST CONNECTED

HOTEL OR RESORT

Mira Hotel, Hong Kong

BEST SPECIALIST TRAVEL AGENT OR CONCIERGE

Abercrombie & Kent

BEST TRAVEL DESTINATION

Shangri-La, At The Shard

Wi-Fi access is rolling out across fleets of airliners, hotels are embracing time-saving technologies, and blogs – from *Instagram* feeds to full businesses – are tailoring travel to individual tastes.

The WIRED x TUMI Innovation in Travel Awards was created to applaud those bringing clever thinking and tools to the sector. It took place on December 15, at TUMI's flagship store on Regent Street, London.

Voted for by wired.co.uk readers throughout November and December, the winners of the six award categories were announced by Jeremy White, WIRED's product editor, and Michael Petry, creative director of TUMI.

"The heart of what these awards are about is people innovating," said Petry. "People bringing new technologies to the forefront, and people really advancing through creative means."

White, who scours the world for products that match the WIRED ideals of beautiful design and effortless useability, referenced TUMI's range of travel equipment – some of which utilise hard-wearing materials also used in the production of Hummer vehicles: "This level of innovation makes the partnership between WIRED and Tumi fit so nicely, because we're looking to work with companies that actually embrace that sort of design."

For more information, see TUMI.com



Jeremy White, WIRED's product editor, and Michael Petry, creative director of TUMI, announcing The WIRED x TUMI Innovation in Travel Awards winners



COLLABORATING ON THE NEXT PHASE OF FINTECH EVOLUTION

WHERE THE CITY MEETS SILICON ROUNABOUT, IT'S AN EXCITING MELTING POT OF AMBITIOUS UPSTARTS AND ESTABLISHED FIRMS. IN THE MIDDLE OF IT ALL, VISA EUROPE HAS LAUNCHED ITS STARTUP HUB – VISA EUROPE COLLAB



isa Europe Collab's new London office at WeWork, on the corner of Primrose Street and Bishopsgate, was chosen for its location. The shared space bridges the City's traditional financial heart with London's startup hotspot.

"There's a disproportionately high percentage of fintech startups in London because of its history of financial activity," says Hendrik Kleinsmiede, co-founder of Visa Europe Collab. "There are around 5,000 startups between Silicon Roundabout, Shoreditch and Canary Wharf, so London was a very logical place to be for emerging, new and revolutionary technologies."

Visa Europe Collab has also set up offices in the cities of Berlin and Tel Aviv. Designed to embrace startups, scale-ups and new ideas in fintech, Visa is interested in any company or idea that relates to payments – a sector that is growing as technologies mature.

"We engage with startups because they have more expertise in these emerging technologies than anyone else," says Niamh de Niese (*right-hand portrait*), Visa Europe Collab's innovation partner for delivery.

Kleinsmiede and de Niese have developed what they call a "diamond process" of exploring such technologies. This entails setting a broad area of enquiry



before narrowing the focus back to a specific area of interest.

While studying the blockchain environment, they began to see opportunities in areas not traditionally covered by Visa Europe, such as in remittances – cross-border money transfers that often carry large fees. These fees can hinder low income groups, such as those receiving money from family abroad. The cost of sending funds to sub-Saharan Africa can be as high as ten per cent.

“We evaluated a number of service providers – startups as well as scale-ups – and settled on Epiphyte because we felt that they hit most of the buttons straight away,” says Kleinsmiede.

London-based startup Epiphyte’s blockchain-powered platform makes moving money as easy as sending an email. For banks, making international payments is a surprisingly slow and expensive process, and they have been working with Epiphyte to solve this problem. Collab has been investigating new ways of sending funds across borders using Epiphyte’s system. The proof of concept enables money to be sent over Bitcoin to any SIM card – thus opening up the possibility of low-cost, immediate cross-border payments. This could have huge implications for millions of people and save billions of pounds in fees. Visit wired.co.uk/visa-collab

VISA EUROPE COLLAB LONDON



NIAMH DE NIESE
INNOVATION PARTNER,
DELIVERY

■ As well as sharing the task of setting Collab’s strategic direction, Niamh de Niese oversees the delivery of all Collab projects, with overall operational responsibility for the management of the London business unit.



HENDRIK KLEINSMIEDE
CO-FOUNDER, VISA
EUROPE COLLAB

■ Hendrik Kleinsmiede, a fintech innovator with two decades of product management experience, co-founded Collab with the mission of identifying and nurturing the best in fintech talent and ideas.

EPIPHYTE

VISA EUROPE COLLAB LONDON STARTUP

■ Epiphyte allows financial institutions and merchants to utilise distributed ledger networks in a safe, secure and legal manner for faster, cheaper, real-time cross-border transactions. “What we now have with the blockchain is the emergence of a worldwide distributed ledger. This set of open standards could do for financial transactions what the internet did for

information,” says Edan Yago (*below, centre*), founder and CEO of Epiphyte. This opens up the potential for sending funds across borders, without paying large remittance fees. It also provides large financial institutions with a secure way to leverage the services being developed by Fintech startups. To make this new, more open world of finance happen, Epiphyte is working on a set of open standards for Bitcoin and other digital assets that would enable adding metadata to tag the transaction’s purpose, sender, recipient identification and more.



D5500

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*Wi-Fi enabled smart device is required to share images.



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At the heart of the image

LA MARZOCCO G3 AQUA

Florence-based Marzocco's professional-grade home coffee machine benefits from the firm's century of experience in the trade. You can spec the G3 to your barista style – go auto-volumetric for consistent espresso shots, or use a manual paddle so you can tweak to taste. Its two steam-wand options enable the perfect microfoam. The custom G3 is US only for now, but a UK version is planned. \$6,200 lamarzocco.com

Personalise your G3 using a range of seven side panels, including blue glass (shown) and walnut

RATED & REVIEWED / EDITED BY KIERAN ALGER & JEREMY WHITE / 049



WIRED used To The Point Espresso (£7.50, 250g) from Norfolk-based greysealcoffee.com



**BREVILLE
BLEND-
ACTIVE PRO**

Fitting all our ingredients into this blender was quite a squeeze. After one minute, the Killer Kale drink was still too fibrous; after two it was tasty, but the chewiest on test. "I'm impressed it handled so many frozen ingredients," says nutritionist Rhaya Jordan. "I like that you can watch the vortex, but hate holding down the power button." **3/10** £50 breville.co.uk
Volume 500ml
Power 300W
Controls One speed; pulse



The Blend-Active Pro comes with a neoprene sleeve to keep your drink cool



PURÉED AND SIMPLE

Which sports blender is best for a delicious nutrient boost?

GOLD BLENDS / GEAR / 051

1. NUTRIBULLET 600 SERIES

Considering the NutriBullet's 600W motor, Jordan was surprised its Killer Kale was chewier than the Tefal's after one minute. Blended for two minutes, it was smooth – but the extra time and power had warmed our drink by 3°C. The Brazilian was superb after just one minute. **7/10** £80 buynutribullet.co.uk **Volume** 680ml **Power** 600W **Controls** One speed; pulse/lock

2. KENWOOD 2GO SPORT

This affordable blender comes with two bottles with sports caps for drinking on the go. Killer Kale blended for two minutes was smoother than the Breville's, but still fibrous. "You don't have to hold the button down, but the machine was so wobbly I held on to it anyway," says Jordan. **4/10** £30 kenwoodworld.com/uk **Volume** 600ml **Power** 300W **Controls** Two speeds; pulse/lock

3. NUTRI NINJA

We made Killer Kale using the Ninja's Auto-iQ Ultra Blend – a combination of pulses, pauses and blending. The result: "Wow. There's no fibrousness," says Jordan. The Brazilian was also very smooth. "The Ninja is noisy," she adds, "but it's the one I'd buy." **9/10** £100 ninjakitchen.eu **Volume** 650ml **Power** 1,000W **Controls** One speed; pulse/lock; two intelligent settings

4. TEFAL FRUIT SENSATION

Jordan loved the glass liquidiser as "you could chill it overnight". It was the only blender to make a drinkable Killer Kale in a minute. "I love it – but I don't like holding the button down that long," declares Jordan. The Brazilian took 90 seconds for a texture to rival that of the NutriBullet and Nutri Ninja. **6/10** £40 tefal.co.uk **Volume** 600ml **Power** 300W **Controls** Two speeds; pulse only

HOW WE TESTED

WIRED asked Rhaya Jordan, nutritionist for Soho's The Juice Well (thejuicewell.co.uk), to put five leading smoothie blenders through their paces. But can these small machines create smoothies that are tasty and nutritious? We made a Killer Kale in each of them to test their ability to grind frozen kale, frozen fruit and ice cubes to a smooth consistency without getting warm. Then we made a Brazilian, with Brazil nuts and frozen strawberries, to see which brought out the best flavour.



THE RECIPES

Both courtesy of The Juice Well

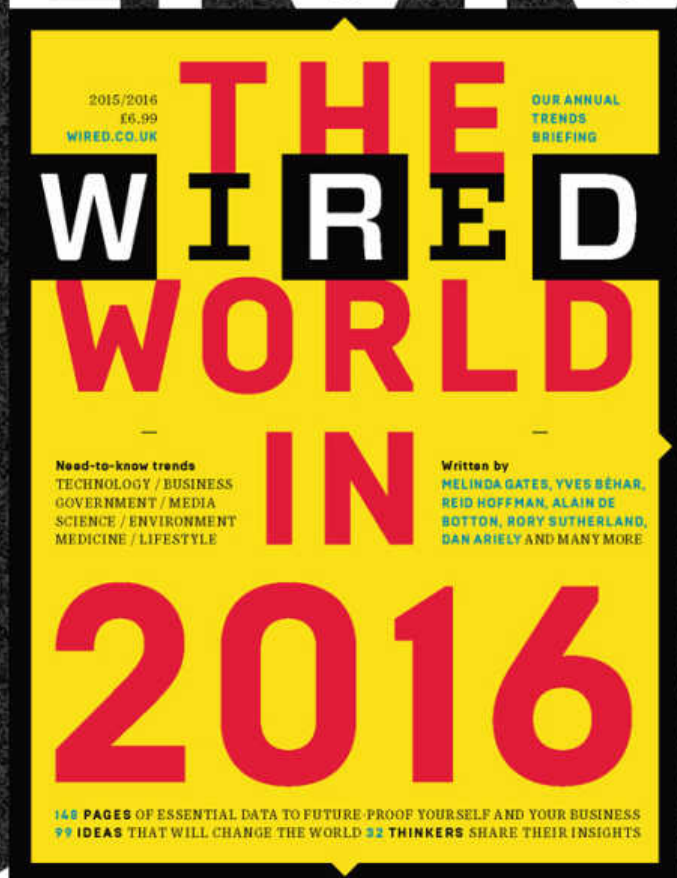
KILLER KALE

300ml coconut water, 10ml E3Live (blue-green algae), **15ml ginger juice**, 10ml lemon juice, **40g frozen apple**, 40g frozen pineapple, **25g frozen kale**, 4 ice cubes

BRAZILIAN

300ml almond milk, 4 frozen strawberries, **1 tbsp chia seeds**, 3 whole Brazil nuts, **1 tsp maca powder**, 1 date, **10ml coconut oil**

THE FUTURE



IS HERE

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AVAILABLE AT WH SMITH AND THE APPLE APP STORE

SMEG'S BLACKBOARD FRIDGE

SMEG's FAB fridge (formally the FAB28RDBB) has had a functional paint job.

There's now a real blackboard surface on the exterior of the 256-litre appliance, so the entire family can unleash its creativity. Note that the FAB28RDBB is easy to wipe clean, so any risqué chalky compositions created during house parties can be quickly erased in the morning. £1,499 smeguk.com



CHEESE / GEAR / 053

FETISH



TRICK OUT YOUR FRIDGE



STOCKTAKING
From anywhere in the world, Egg Minder knows how many eggs you have. Welcome to the internet of silly things. \$50 quirky.com/invent/243958



AUDIOVISUAL
The Tribby is a connected speaker that magnetically sticks to a fridge. It can play radio, take internet calls and display notes sent over the web to an e-paper screen. £159 invoxia.com/en/tribby



1



2



3



4



5



COOK IN THE WILD

Take your cuisine out of the kitchen with WIRED's pick of outdoor accoutrements

1. EVA SOLO TO GO GRILL

At just 32cm in diameter and 40cm high, the Eva Solo To Go is made for barbecues on the move. Inside its enamelled steel shell, a 27.5cm chromium-plated grill sits atop an easy-to-empty charcoal bucket. Heat-resistant silicone handles make it simple to transport. £160 evasolo.com

2. ULAEU OUTDOOR KITCHEN

The Estonian-engineered ULAEU has all you need for an outdoor cook-up. Its modular base unit can be customised with a kitchen sink, charcoal grill, burners and a firewood rack that's built to withstand all weathers. From £1,572 ulaelu.com

3. OPTIMUS SVEA STOVE

This stove's trademark brass tank and windshield, coupled with a stable liquid gas burner, delivers adjustable high temperatures at sea level, at altitude and even in harsh conditions. It weighs 550g, and a tank of fuel gives about 50 minutes' burn time. £95 handeye-supply.co.uk

4. GSI HALULITE MICRO DUALIST

Squeezed into a 14cm x 14cm x 15cm package, this has a cooking pot, a strainer lid, two bowls, two insulated mugs, a stove bag and two utensils. Integrated nesting lets you stow a micro stove and a 110g fuel canister. £60 gsioutdoors.com

5. ROCCBOX COMPACT PIZZA OVEN

This outdoor-friendly oven weighs 20kg and is made from multiple layers of stainless steel, with an insulated jacket and silicone outer sleeve. But it's the insulated internal stone shelf that makes it perfect for pizza. Running off gas or wood, it can reach temperatures up to 500°C within 15 minutes. £370 roccbox.com

FETISH



HOW TO ROAST MEAT ON A SPIT

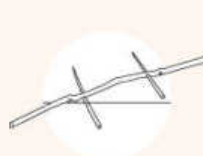
1. Cut your wooden spit to the required length and sharpen the point with a knife.



2. Perforate the spit in two places to accommodate skewers for securing the roast.



3. Split, pare and whittle a straight section of branch or sapling stock for skewers.



4. Locate the skewer-fastening points for the roast and push them through.

A TWIST ON PASTA

CARB CURBING

Still committed to the New Year diet? Spaghetti can have 221 calories per serving – but courgette “noodles” have just 41. Shun the carbs by twisting out a veg alternative with a spiraliser.



The Inspiralizer

A one-piece model, the Inspiralizer offers four shapes: ribbons, fettuccine, linguine and spaghetti. Counter clamps and a dual vacuum base stop the machine from moving around when you are slicing tougher vegetables such as celeriac. £40 juiceland.co.uk



Cuisique Premium Spiraliser

This acts as a grater, mandolin and juicer all in one. Suction feet on the base keep things steady, and the four interchangeable blades slice food into a measuring jug, so your “courgetti” won’t make a mess. £30 cuisique.co.uk

1. TSUKI JAPANESE CHEF'S KNIFE

About 5mm larger than the Damascus, this design has a Japanese VG-10 stainless-steel core. Richard Bainbridge favoured its comfortable grip out of the two knives tested.

"It increases the feeling of control over the knife," he says. It also performs well when filleting, which he attributes to the blade width. **9/10** £60 *nisbets.co.uk* **Size** 20.5cm **Time to fillet fish** 9 seconds **Time to slice onion** 28 seconds **Time to chop parsley** 4 minutes

2. DAMASCUS 20CM CHEF'S KNIFE

The curvaceous body makes for a sophisticated design, with a riveted handle and folded steel in the blade that Bainbridge describes as "amazing". Even though the onion slicing took longer using this knife, our tester was still impressed with

the results: "This was better for slicing an onion, due to the blade's width and good rock." **8/10** £75 *lakeland.co.uk* **Size** 20cm **Time to fillet fish** 9 seconds **Time to slice onion** 37 seconds **Time to chop parsley** 5 minutes

HOW WE TESTED

With the help of chef Richard Bainbridge, owner of Norwich restaurant Benedicts and renowned for his appearances on BBC Two's *Great British Menu*, WIRED tested two slick chef knives to see which came out top. WIRED timed how long it took Bainbridge to fillet a 130g fish, slice a medium-sized onion and chop 100g of fresh parsley. Each knife was assessed on comfort, design and sharpness, and given a score out of ten.

TEST

SHARP EQUIPMENT

WIRED puts two pro-style chef knives on the block to see which has the edge

TEST

GASTRO GASKETS

Pressure cookers reduce your energy bills and cooking times.

Michelin chef Atul Kochhar tries his signature dish in four



1

056 / GEAR / VOLANT VICTUALS

HOW WE TESTED

With the help of Michelin-starred chef Atul Kochhar (atulkochhar.com), patron of renowned Mayfair restaurant Benares, WIRED tested four pressure cookers. They claim to save energy by reducing cooking time by up to 60 per cent. In our test, Kochhar recorded how long it took to prepare his classic dal makhani, usually slow-cooked and braised overnight. Each model was also rated on its design and ergonomics, versatility, ease of use and safety, and given a WIRED score out of ten.

2



1. RAYMOND BLANC COOKWARE

"The one-handed lid operation was very comfortable and the design easy to use," says chef Atul Kochhar. "The cooker works well for cuts of meat, but the veg wasn't as good as I'd have liked." **9/10** £100 cookshop.raymondblanc.com **Time taken to make recipe** 27 minutes **Capacity** 5.5l **Material** Stainless steel

3



2. PRESTIGE ALUMINIUM

Designed with a deep lid for larger joints, this model has 5lb, 10lb and 15lb cook control settings. "It cooked my dish in the shortest time, which was impressive, but it was bulky. I'm not keen on its traditional safety valve operation, either." **7/10** £74.99 lakeland.co.uk **Time taken to make recipe** 23 minutes **Capacity** 6l **Material** Aluminium

4



3. KUHN RIKON

It took the longest to make the dal but it achieved a good consistency. "It felt safe," says Kochhar. "And practical for a family of four." A cone-shaped lid reduces how much steam is needed. **6/10** £104.99 lakeland.co.uk **Time taken to make recipe** 28 minutes **Capacity** 5l **Material** Stainless steel

4. TEFAL CLIPSO PLUS

Kochhar was impressed by the good-quality design and sturdiness. It comes with a steaming basket, and has two cooking programmes. "I love the shape and one-hand operation," says Kochhar. **8/10** £140 tefal.co.uk **Time taken to make recipe** 25 minutes **Capacity** 6l **Material** Aluminium and stainless steel



Digital extra!

Download the WIRED app to get Kochhar's dal makhani recipe





Zeppelin Wireless.
Next level audio
performance.

Bowers & Wilkins

BOROUGH FURNACE SKILLET

Every 23cm Borough Furnace skillet is handmade to order in Syracuse, New York, using a traditional casting process that's been updated to play nice with the environment.

Crafted from recycled iron, the long-lasting metal mixture is melted by a furnace burning waste vegetable oil. Each hand-cast, hand-finished pan is seasoned with organic linseed oil, so it's ready to cook with right out of the box. \$280 boroughfurnace.com

The long, n-shaped handle dissipates heat, so it remains cool to the touch



GIVE YOUR MEAT AN UPGRADE

Restaurant-quality results are made easy with these kitchen essentials



RARE QUALITY / GEAR / 059

1. GLOBAL KNIVES MEAT SHEARS

Decent kitchen shears take the pain out of trimming excess fat from meat. Global Knives' shears are made from corrosion- and abrasion-resistant molybdenum vanadium stainless steel. Micro-serrated blades, a lower fulcrum and ergonomic handles give you controlled cutting power. £100 globalknives.uk

2. STEAK LOCKER DRY-AGER

This patented, smart dry-ageing fridge is a luxury for carnivores – it incorporates everything you need to age your steak or charcuterie meats. Fan-forced air and a digital hygrometer give you control over humidity and temperature. Germicidal UVC lamps ensure bad bacteria are kept away. \$1,399 steaklocker.com

3. CRUCIAL DETAIL MEAT BRICK

Made in editions of 50 or 100 pieces, this eye-catching skillet offers the perfect stage for at-the-table theatre. Created under the watch of Czech designer Martin Kastner, Crucial's cast-iron brick snaps into a stainless-steel frame to give you the ideal surface for finishing off sous vide steaks. £90 crucialdetail.eu

4. ANOVA PRECISION COOKER

The Anova attaches to a pot and uses a built-in pump to circulate up to eight litres of water around your pan at temperatures between 25°C and 99°C. Its app lets you choose what you're cooking and fires instructions on perfect timing and temperature directly to the Anova for spot-on results. \$229 anovaculinary.com

FETISH

PUSHED FOR TIME?

Aerate your wine with a blender

1. CHOOSE YOUR RED

Stuck? Gary Owen, private account manager at Berry Bros, picks three of its best reds for steak. bbr.com

BUDGET

2013 BERRY BROS. & RUDD Extra Ordinary Claret, Ch. Villa Bel-Air, Bordeaux, £14.50. "Full of fruity character."

BIRTHDAY

1999 CLOS DU MARQUIS St Julien, Bordeaux, £42. "This is really superb – refined and elegant."

BONUS

2000 CH. CHEVAL BLANC St Emilion, Bordeaux, £915. "One of the finest expressions of Merlot on Earth."

2. POUR INTO A BLENDER

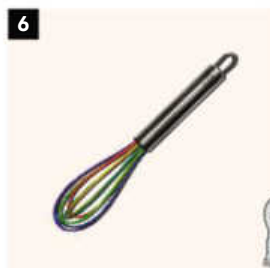
The SMEG BLF01RDUK (£150 smeguk.com) comes in claret red. Pour in the whole bottle.

3. NOW BLITZ IT

Whizz on full power for 30 seconds to mix in lots of air. Once it's settled, it's ready to serve.

GENIUS BAKED IN

Products that push even self-raising ingredients to new heights



WIRED'S FAVOURITE BAKING APPS



Drop Recipes
iPhone and iPad, free
getdrop.com



The CakeUlator
iPhone, iPad and Android, £2.99
cakebaker.co.uk



Primrose Bakery
iPhone and iPad, £2.99
primrose-bakery.co.uk

060 / GEAR / HIGH-WHISK VENTURES

1. THE FOWNDRY ALUMINIUM ROLLING PIN

Funded via Kickstarter and machined from a block of aircraft-grade aluminium, the Fowndry rolling pin couldn't be more 21st century. Its measurements are laser etched on to a sleek anodised body with a finish that comes in a range of colours. And its superior heat-conducting properties keep butter from melting in your dough for longer than a wooden pin would. £40 thefowndry.com



2. EVA SOLO TIMER

Timing is everything in the kitchen, particularly if you are expecting professional results from your baking. The simple silicone-coated Eva Solo Timer lets you keep to your cooking times with minimalist style. £15 evasolo.com

3. JOSEPH-JOSEPH TRI SCALES

A brilliant space saver, the Tri Scales has fold-out legs to create a platform for any bowl, but it also folds back to a third of its size for storage. There's also a clever Add & Weigh feature that lets you measure out ingredients into the same bowl during any recipe. It'll weigh up to 5kg, with an LCD display and touch-sensitive controls taking the faff out of any pre-bake prep. £32 joseph-joseph.com

4. HESTON BLUMENTHAL MEASURING SPOONS

Inspired by Britain's modern-day Willy Wonka, these measuring spoons bring a little bit of Blumenthal precision to your kitchen. The two nesting spoons feature a clever slider that sorts your heaped from your level without wastage, by scooping anything from a ¼ teaspoon to a full tablespoon and pushing any excess back. £15 salterhousewares.com

5. CALIBOWL ULTIMATE MIXING BOWLS

Created on the West Coast, each bowl features a non-spill lip around the top, designed at the correct angle to push your cake batter on to your utensil without any overflow. The set of three 20oz, 40oz and 95oz bowls is made from recycled materials, is microwave safe and nests elegantly, making it the perfect space saver for cramped kitchens. \$30 calibowl.com

6. KUHN RIKON SILICONE WHISK

Whisks are essential in any baker's toolkit – but they're certainly not all created equal. Crafted from non-stick silicone, this Kuhn Rikon mixer brings a bit of design flair to your whipping with its stylish multicolour balloon, a stainless-steel grip and even a handy hanging hook. £13 kuhnriikonshop.com

KITCHENAID PRECISE HEAT MIXING BOWL

The classic KitchenAid stand mixer is an icon – but this bowl adds smarts to old-school style. The stainless-steel bowl liner and transparent

lid make it easy to use and fast to clean. It'll heat for ten hours, whether clipped to your mixer or on its own, making it perfect for bread, chocolate sauces and even the ever-tricky Italian meringue. £279 kitchenaid.co.uk



The precise control lets you select any temperature from 20°C to 105°C, in 1°C gradations

Shot using British Standard kitchen cabinets. Available online only, WIRED likes the crafted, utilitarian look of the solid wood units. From £400 britishstandardcupboards.co.uk



Experience more

AT THE WIRED RETAIL ONE-DAY EVENT, JEAN-CHRISTOPHE HERMANN, VALTECH'S EVP OF GLOBAL RETAILING, EXPLAINED HOW SAFE IS THE NEW RISKY AND SELLING PRODUCTS IS SIMPLY NO LONGER ENOUGH

"You have to accept the idea that what used to work may not work very soon," said Jean-Christophe Hermann, EVP of Global Retailing at Valtech, when he took to the stage at WIRED Retail on November 23. Today's retailers, he asserted, can no longer simply sell products. They must pivot and expand into providing experiences.

The merging of the online and offline allows these retail experiences to be both inspiring and exciting, says

Hermann. But the new landscape can also be "terrifying" in its unpredictability. Amazon, he noted, is the most valuable company in retail and yet it has no physical store footprint.

So, how can retailers with real-world and digital outlets navigate the next five years – and not just survive, but also thrive?

"Today, success requires a capacity to cope with a permanent state of innovation," said Hermann. In essence, we



04

Number of continents Valtech serves its clients

22

Number of offices Valtech operates globally

23

Number of years Valtech has delivered digital marketing innovations

must continue to innovate and adapt, rather than take the iterative "one step at a time" approach of years gone by.

Hermann went on to introduce some of the work Valtech has undertaken in the space to help companies integrate digital into their innovation strategies.

In shops and outlets, it's common for consumers to have difficulty finding experts to help with their purchases, especially for things like running shoes, said Hermann. "So we thought, 'if you put in a 3D motion-sensor connected via Bluetooth, what could you do?'"

The resulting technology activates when a potential buyer picks up the trainers. Sensing movement, a nearby display unit explains the technical specifications of the shoes, covers the design and production

THE VALTECH PERSPECTIVE



The event

WIRED Retail was held on November 23, 2015 and was the second execution of the event. With a Startup Stage and Main Stage it gathered established industry players and sector newcomers under one roof. Valtech was anchor partner. "WIRED Retail is a unique moment in the year to really share our most recent innovative work that we hope will be inspiring for retailers throughout Europe," says Jean-Christophe Hermann, (left) Valtech EVP of global retailing.

The venue

For the first time, WIRED Retail took place at the St Pancras Renaissance Hotel, London. "To get access to this venue is just so marvellous, and I think it's a perfect place to express what we're facing today," says Olivier Padiou, chief operations officer at Valtech. The imposing architecture offered an interesting contrast to the future-facing digital platforms being described on the Main and Startup Stages.

The breakfast

"The Valtech breakfast (above) was a chance for a few people to really have a conversation about the future of retail," says George Smith, digital managing director of Valtech UK. "I think it's that interplay between startups and established businesses and how they can teach each other that makes it a fascinating area." Smith spoke at WIRED Retail 2014 about the power of orchestration, integration and evolution in retail.

The talks

According to David Rowan, editor of WIRED, the Retail event was about bringing the future of retail "To an audience made up of the incumbents, the innovators and the people trying to find new ways to let the customer acquire what they want - in a seamless and friction free way." Rowan hosted the Main Stage talks, which were curated by Sophie Hackford, director of WIRED Consulting and Education.

processes, and lists the kinds of terrain they're best suited to.

"That's just one example of how you turn a dead shoe into an experience," explained Hermann.

Elsewhere, Valtech has been working with Canadian firm Ivanhoe Cambridge, which has interests in over 100 centres globally. The mission was to help people buy gifts for their family and friends near to Christmas. The project solution involved installing interactive display units in malls, featuring 3D animated hostesses who make gift suggestions and allow users to explore additional available products.

"They've been testing this in Montreal and Vancouver," said Hermann. "And early results are very promising."

This is another case of taking "dead" products and building experiences around them. A process that's more important for less exciting goods.

"If you think about it, selling kitchen appliances is a tough job," he said.

To address that, Valtech worked with appliance producer Thermador to create a virtual reality experience. This gave customers a better understanding of how their new kitchen might look and feel, via a VR headset.

In closing, Hermann said today's retailers must be bold. They should have a permanent feedback loop with customers, de-couple innovation from annual budgets and keep an eye on agile startups. Because "Safe," he said. "Is definitely risky."

For more information, see Valtech.com

A smarter pad

For sketching, taking notes and jotting down ideas, paper is still a worthy medium. Now you can digitise those musings with Wacom's Bamboo Spark folio

Wacom is looking for test subjects to submit reviews and feedback of the Bamboo Spark. For your chance to win a smart folio, visit wired.co.uk/wired-insider/2016/bamboo-spark



W

Wacom's Bamboo Spark smart folio lets you scribble, sketch and make notes on any paper, and turn them into digital, editable files. The black neoprene case is embedded with an electro-magnetic resonance board which records the Wacom pen's movements. These are

synced via Bluetooth with the *Bamboo Spark* iOS and Android app, making digitised versions of your notes that can be easily edited.

New for 2016, the app can now support ink-to-text conversion, so anything written on the smart folio can be transformed to text, added into digital documents or edited on another device.

Ink-to-text conversion is supported in 13 languages, including English, Japanese, German and Korean.

The notepad itself can store up to 100 pages of content and comes in three varieties – with a pocket to store a smartphone; with a sleeve for a tablet; or specifically designed to hold Apple's iPad Air 2. You'll never forget that winning app idea again. wacom.com

BAMBOO SPARK: THE DETAILS



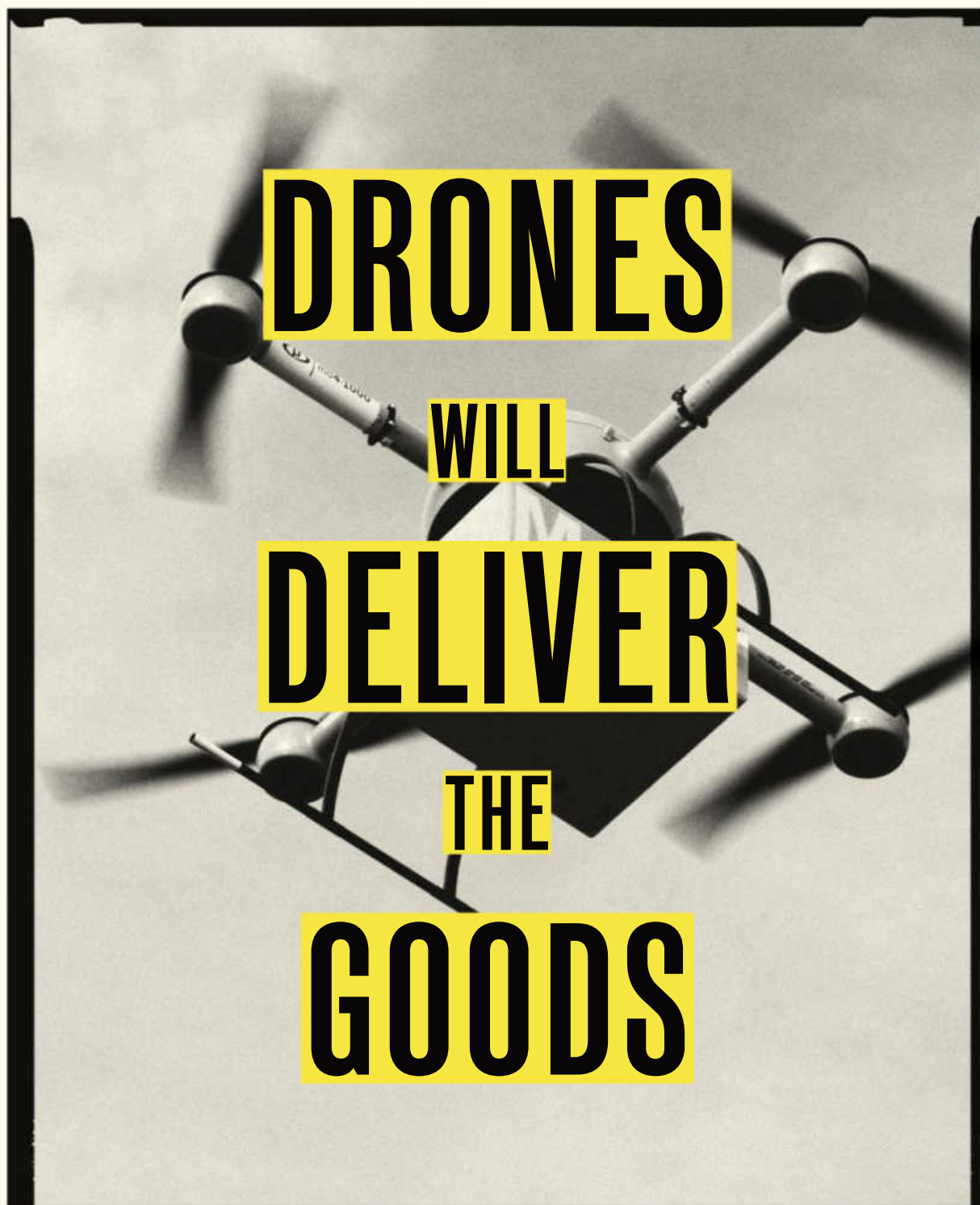
The Bamboo Spark smart folio ships with a smart ballpoint pen. It's exactly like writing on paper – because you really are just writing on paper.



To save your writing and sync to the Bamboo Spark app, click the folio's button and notes will be saved via a Bluetooth connection.



Founded in 1983, hundreds of thousands of designers and creatives use Wacom's tools in their professional and daily lives.



**AND SEVEN OTHER THINGS WE LEARNED
AT WIRED RETAIL 2015 ABOUT THE
FUTURE OF OFF- AND ONLINE SHOPPING**

Edited by Greg Williams Written by Stephen Armstrong

Event curated by Sophie Hackford

Photography: Charlie Surbey



If you couldn't get a ticket to our second annual WIRED Retail event, held at the St Pancras Renaissance Hotel in London on November 23, here are the key insights and inspiration from our Main and Startup stages. Meet the innovators building the future of commerce and challenging fundamental assumptions about the supply chain, from distribution to the shop floor.

MEET THE SPEAKERS

066





OPPOSITE PAGE:

left to right, top to bottom

◆ **Henry Stuart** CEO and co-founder, Visualise; **James Allgrove** head of UK growth, Stripe; **Steve Callanan** CEO and co-founder, WIREWAX

◆ **Jean-Christophe Hermann** EVP global retailing and consumer goods, Valtech; **Anisha Singh** co-founder and CEO, mydala

◆ **Stefan Siegel** founder and CEO, NOT JUST A LABEL; **Siavash Ghorbani** co-founder and CTO, Tictail

◆ **Yariv Bash** CEO, Flytrex Aviation; **Jo Bertram** regional general manager UK, Ireland & Nordics, Uber; **Sebastian Siemiatkowski** co-founder and CEO, Klarna

THIS PAGE:

left to right, top to bottom

◆ **Bram de Zwart** CEO and co-founder, 3D Hubs; **Jessi Baker** CEO and founder, Provenance; **Cristian van Tienhoven** senior manager, Amazon ◆ **James Crawford** CEO and founder, Orbital Insight; **Allan Martinson**, **Ahti Heinla** and **Keith Cornell** Starship Technologies

◆ **Billie Whitehouse** designer and director, Wearable Experiments; **Ken Denman** CEO and president, Emotient

◆ **Si Brown** CMO and co-founder, skignz; **Robert Gentz** co-founder, Zalando; **Paul Clarke** director of technology, Ocado Technology

OCADO DELIVERS MORE THAN ONLINE GROCERIES

Paul Clarke
*Director of technology,
Ocado Technology*

Most people think of Ocado as the people who drive cute home-delivery vans, the company's CTO Paul Clarke told WIRED Retail. What they may not know is that the company is developing humanoid engineering and warehouse-building robots, an AI to predict food orders, swarming bots to manage delivery and even robotic hands that mimic the human grip.

"We are seen as a tech company outside the UK," he explained, discussing a new centre in Poland as well as the SecondHands maintenance android that learns its skills by watching human staff. Ocado, he said, is hiring increasing numbers of dedicated tech staff, as well as expanding globally, with the aim of putting online some of the world's largest bricks-and-mortar retailers.

"If you're going to realise this vision, then you're going to have to pepper the planet with

delivery warehouses. So it's worth inventing robots that can help you build and maintain them," Clarke said. "It's a new, scalable and logical way of building."

Ocado's AI is fed huge amounts of customer data. When this is passed in turn to autonomous delivery vehicles, connected home appliances and smart packaging, it will create a "smart grocery pipe delivering the right groceries at the right time without the customer having to order".

"Online grocery retail is very different from other kinds of online retail, because we have to contend with multiple temperature regimes, product form-factors, short shelf-lives, crushables, food-tech segregation rules and so on," he said. "If you can do online-grocery retail, then you can do other kinds of online retail – but the reverse definitely doesn't follow."



OUR SPENDING HABITS ARE WRITTEN ALL OVER OUR FACES

Ken Denman
CEO and president, Emotient

It's not quite *Minority Report*, but measuring the feelings of shoppers as they walk through a shop or experience new products may be the next big thing in retail, Ken Denman, CEO and president of engagement and emotion-engagement firm Emotient, said.

Emotient, acquired by Apple in January, uses software detectors, high-definition cameras and deep neural networks to measure subconscious micro-expressions that flicker across the face unconsciously – including joy,

disgust, contempt and fear. In a recent detergent focus group, Denman told the room, Emotient accurately predicted which fragrance people would prefer simply by watching their faces.

"Emotions start spending," Denman argued. "Since the beginning of time we've struggled to understand how people really feel. Hundreds of billions of dollars are spent every year trying to understand what customers think about products or the customer experience – and the reality is we've been guessing."

Denman demonstrated Emotient's engagement engine tracking people as they watched a risqué Super Bowl ad from a fast-food chain – understanding which elements brought out joy and disgust in men and women. "What has historically taken \$50,000 or \$60,000 and seven to eight weeks now takes four or five days and as little as \$6,000," he explained.

068

THE BLOCKCHAIN LETS YOU TRACE SOURCING

Jessi Baker
CEO and founder, Provenance

Issues such as child labour and ethical sourcing make it hard for consumers to trust big brands – but the blockchain may be the solution, according to self-proclaimed troublemaker Jessi Baker, founder of ethical-sourcing consultancy Provenance.

The blockchain is a permanent digital record of any transaction or event, initially used to record bitcoin transactions. Baker uses it to bring information from supply chains to consumers, using blockchain technology to confirm a product is authentic, organic or not made in a country with poor human rights.

"The blockchain is an amazing way of brokering and comparing open and accountable information about companies – even if production and operations are happening across the world from the point of sale," Baker enthused. "We are tracking fish, for instance – verifying them and committing them to an open data stream so that everybody in the world can see where that fish has been caught, which company bought it and where it ended up on the shelf."

Baker told the room that this sort of open monitoring could restore trust to brands. "A brand used to be a personal mark on a product back in the medieval village," she said. "The printing press led to advertising and a huge gulf between reality and perception. Now everything from shoes to crisps are claiming to be handcrafted and we're experiencing a crisis in brand trust."

Fully transparent brands such as Abalone and Outerknown can now feed information to the consumer's smartphone. "Some might even go as far as to say that in this hyper-connected world perhaps being more transparent is the new power," she said.



**'THE BLOCKCHAIN IS AN AMAZING WAY OF COMPARING
OPEN AND ACCOUNTABLE INFORMATION'**

Jessi Baker

LAST-MILE PROBLEMS CAN BE SOLVED BY EARTHBOUND DRONES

Ahti Heinla

*Co-founder, CEO and CTO,
Starship Technologies*

It's the final mile in any online delivery that's holding e-commerce back, Ahti Heinla, ex-Skype chief technical architect and co-founder of Starship, said. And that mile costs the UK £300 million in wasted time and energy.

E-commerce amounts to just 15 per cent of retail spend in the UK – and eight per cent in the rest of Europe. A typical British household wastes about an hour each week on personal shopping trips. Reducing the cost of the final mile of delivery – currently between about £3 to £7 per parcel – could lower prices and boost efficiency, Heinla argued. His solution? A fleet of small, lightweight, autonomous delivery robots that eliminate the human labour and heavy vehicle cost from the last-mile equation.

Starship plans to launch in the UK in Q2 2016, with a network of automated hubs to store, load and charge the six-wheeled vehicles, each capable of carrying two shopping bags up to 3km within 30 minutes of an order.

"Some people are putting their faith in drones, but I believe there are lots of unanswered questions," Heinla said. "From safety and regulatory barriers to energy efficiency and public perception. People don't like things flying over their back gardens, carrying other people's groceries."

Starship's robots travel on the pavement at 7kph to match pedestrian traffic, Heinla explained. Each robot's lid is locked to prevent theft, and can be opened only with a code texted to a customer's phone. GPS and a video camera should also deter potential thieves, he argued.

Starship does have a few regulatory hurdles to trundle over, Heinla said. "Local government does need to give permission for these things to go on the pavement," he explained. "But we have talked to many of them and they love it – these robots reduce congestion, reduce pollution and allow people to live longer lives, independently, at home."



YOUR CUSTOMERS' HOBBIES ARE KEY

Anisha Singh

Co-founder and CEO, mydala

If daily-deals sites are going to survive, they need to differentiate more over values than price, said Anisha Singh, founder of Indian local-deals site mydala. Singh learned the hard way – she founded mydala in 2009 as a daily-deals platform letting offline merchants sell online, but struggled when well-funded rivals launched against her. "We were slated to die," she explained. "The only thing that saved us was understanding the user."

In India, that meant turning to ABC – astrology, Bollywood and cricket – to offer content, deals and tie-ins to tap obsessions.

Mydala began with astrology deals, then built online games to help launch Bollywood movies, before providing cricket coverage.

The site also took inspiration from mobile banking in Africa to introduce phone payments and open up rural India, where credit cards are scarce – all of which helped pull in the site's current 36 million regular users in 209 cities.

Mydala now crunches the data it holds on shopping patterns to help merchants market at a micro level, down to snacking habits – by suggesting a local pizza restaurant offers a discount on certain days for some users.

Offering the right deals and the right content is key, Singh said. Because the sites are so busy acquiring new users, they forget their biggest champions are their existing customers. "Retention is much more important," she argued. "It doesn't have to be the coolest new tech that is going to get you the user – it's what you do when you get there."

MEASURING FOOTFALL BY SATELLITE IS MORE USEFUL THAN SALES FIGURES

James Crawford
*CEO and founder,
Orbital Insight*

Using drones and satellites to film shops from the sky can add to the bottom line, Orbital Insight's CEO James Crawford said. It's all about counting cars.

Using satellites, the firm can gather imagery from eight million km² of land – the size of the US – every day. It has used it to measure deforestation, city development and the fortunes of high-street shops. The addition of drones is about to boost that by a factor of ten, he explained. Using deep-learning AI neural networks, Crawford's team can record and analyse the number of cars arriving at a shop, and help retailers understand their shoppers or the benefits of targeted marketing.

"Because we have six years of data we can look at weekly patterns," he said, flicking through satellite photographs of sprawling car parks. "Looking at the [Australian supermarket] retailer Coles, it turns out Wednesdays are their second biggest day. At first we thought this was a bug – but they have a ten per cent senior discount then." The US store Ross has a similar discount peak on Tuesday – Orbital Insight's tech now helps retailers plan and measure the effect of sales or promotions in near real-time.

Comparing similar stores – or aggregating the numbers for 50 key retailers at a macro level – enabled Crawford to compete with the predictions of Wall Street analysts. Measuring traffic to and from The Home Depot and rival retailer Lowe's over five years showed that the former was outperforming the latter – and allowed Orbital Insight to predict company results accurately. At the same time, grouping regional-store traffic allowed the team to prove it was bad weather and not online shopping that was hurting sales at physical locations over the winter of 2014.

"Drones allow much higher resolution," Crawford added. "We can see people going in and out, understand if they've purchased something and where the best locations are – even in developing countries or China's new cities."

VR IS YOUR NEW SALESPERSON

Henry Stuart
CEO and co-founder, Visualise

Imagine J-Lo as your personal shopper in a 3D virtual-reality Harrods where you're snapping up bargains with your friends – as avatars – on hand. Henry Stuart, CEO at VR production house Visualise, outlined this vision for the bright new VR-powered retail future.

"Brands like Nike could have infinite stores that defy gravity, where Ronaldo or Wayne Rooney chat to customers," he suggested, challenging retailers to "think about what kind of virtual presence you want if not constrained by the real world."

Visualise has worked with travel agent Thomas Cook to produce "Try Before You Fly" holiday demos, allowing people to take virtual five-minute holidays. Stuart said this led to a 190 per cent increase in sales after a VR trip. Audi overcomes small city-centre showrooms lacking the space to show its full range

by using VR headsets, where the company's designer talks to customers about various models and joins them on a test drive.

With big-name brands such as Oculus, Google, HTC and Sony all launching VR sets this year – and Apple apparently interviewing VR experts ahead of a rumoured launch – Stuart predicted 12m headsets sold by 2017, driven by gaming, but closely followed by entertainment and retail.

"VR is an emotionally connected experience," Stuart told the room, recalling a trial where VR avatars caused users to become flustered by whispering. "Once you add haptic peripherals, you'll be able to pick things up and feel them – making shopping appear incredibly real." The next step, he suggested, could be a metaverse – a series of VR universes with virtual shops selling goods that simply couldn't exist in real life. "Why would you want to come back to real life," he asked – avoiding any mention of *Second Life*...



FASHIONS CHANGE, BUT WE'LL ALWAYS NEED THE REAL WORLD

Robert Gentz
Co-founder, Zalando

The future of online is offline, Robert Gentz – co-founder of Berlin-based multinational fashion e-commerce site Zalando – told a packed hall. To deliver the best consumer experience, he explained, web-based companies need to embrace a real-world ecosystem – including expert consumer advice, real-world stores, phone chats and speedy delivery, ideally within three hours.

Zalando's stylists offer advice over IM and customers click to order from local stores in what he described as a fashion ecosystem. "If brands are connected to consumers, if

offline and online are connected, an ecosystem can provide better consumer experiences."

After the company's autumn 2014 IPO, Gentz launched a group rethink, "Moving from operating as an online retailer to an online fashion company with an OS that connects the entire fashion world," he explained.

The Zalando OS allows customers to see, say, Pharrell Williams wearing a pair of trainers, identify them, browse the range and find and reserve a pair in a nearby shop. Zalando can also arrange home delivery.

"This is only possible through collaboration via an OS everyone is plugged into," he said. The company is investing in recognition software, collaborative inventory systems and last-mile delivery options.

Gentz was confident, however, that his risks were low. "The fashion market is huge, and everyone uses it every day," he said. "No one has decided to not get dressed today. In ten years, I'm not sure if you'll still have a car, I'm not sure if you'll still have a phone – but I'm pretty sure you still won't be naked."



'IF OFFLINE AND ONLINE ARE CONNECTED, AN ECOSYSTEM CAN PROVIDE BETTER EXPERIENCES'

Robert Gentz

072



PHOTOGRAPHY: MICHAEL PALEODINOS

WIRED RETAIL STARTUP STAGE

Representatives from each of the 17 growth-stage companies listed below spent nine minutes pitching in competition to the WIRED Retail audience of experts and investors. Congratulations to CommonSense Robotics, who won the judges over.

Louis Deane VISR VR
Elram Goren CommonSense Robotics
Yoni Nevo Cimagine
Pierre Noizat Paymium
Karoline Gross Smartzter
Mohamed Haouache PopUp Immo
Charles Lee Containers
Miki Kuusi Wolt
Christian Zigler Shopbox
Danny Hawkins Quiqup
Thomas Sheppard (above) Presence Orb
Peter Ellen Big Data For Humans
Alexander Kayser yReceipts
Marjorie Leonidas Taggstar
Dominic Clark Tyres on the Drive
Matt McRoberts Appboy
John Garner Social Superstore

WATCH WIRED RETAIL ONLINE

You can see and hear the speakers from the Main Stage at
wired.co.uk/wired-retail-2015

On the evening of November 22, ahead of WIRED Retail, WIRED and Tata Communications brought together technology experts and visionaries to debate the changing nature of retail, as technology continues to transform the sector, offline and on.

Tata Communications – part of the \$108.78bn (£85bn) Tata group – has the world's biggest wholly-owned global fibre-optic cable network, allowing businesses to reach 240 countries and territories. A quarter of the world's internet routes travel over the company's network, which underpins its cloud partnerships with tech giants such as Microsoft, Amazon, Google and Salesforce.

Despite this, Julie Woods-Moss, CMO of Tata Communications and CEO of the company's NextGen business, remains open to learning from others, by collaborating with promising startups.

"So far we've scanned over 200 companies and invested in about 20," Woods-Moss explained. Indeed, Tata Communications is keen to cultivate and promote innovation, which led to its partnership with WIRED Retail.

Conversation at the dinner covered how western markets are expanding into – and navigating – emerging markets, the potential applications of blockchain technology, and how retailers are gaining more ways to engage with consumers.

Woods-Moss sees three key trends driving changes driving retail and e-commerce. Firstly, new experimental retail and e-commerce channels will push innovation in the industry and give digital shoppers new kinds of shopping experiences. Secondly, retailers and e-commerce players will increasingly harness applications, such as virtual reality, for new shopping experiences that will connect with consumers by new means, and enable them to encounter and engage with

Retail re-invented

COMMERCE IS BEING TRANSFORMED BY AN ARRAY OF DIGITAL, CONNECTED TECHNOLOGIES. PRIOR TO WIRED RETAIL, A VIP DINNER GATHERED THE SPEAKERS TO DISCUSS THESE CHANGES IN DEPTH



Above: A guest discovers the future of the sector in the WIRED Retail test lab

products in a unique way. And thirdly, further down the line, machine-to-machine technologies are set to transform the delivery of goods to match instant ordering with almost-instant delivery. All of these innovations rely on ubiquitous connectivity, which is where Tata Communications' expertise lies.

On the WIRED Retail Main Stage, speakers sketched out ideas on the future of the sector. David Rowan, WIRED editor, introduced them.

"We have people making delivery robots and drones that link you to the products you want," he said. "We have people from logistics companies and others using virtual and augmented reality. We have entrepreneurs who are simplifying the whole experience of buying things."

With the pace of innovation gathering speed in retail, the way we shop is about to be transformed. **See tatacommunications.com**

GUESTS AT DINNER



Bram de Zwart,
co-founder &
CEO, 3D Hubs



Julie Woods-Moss, CMO of
Tata Communications, with
WIRED's Sophie Hackford



Jens Kellersmann,
head of PR, EMEA,
at Wacom



Cheyney Robinson,
chief creative
officer, Europe, IBM



James Allgrove,
head of UK
growth at Stripe



A

apps, cryptocurrencies and digital wallets are just some of the rapidly maturing technologies impacting banking and payments systems. In the fourth and final Accenture and WIRED co-hosted dinner salon, attendees discussed how the sector's incumbents and newcomers might collaborate as digital banking progresses.

"The way forward is for banks to gradually absorb the technology the fintech's are developing," says Jeremy Light (*left*), managing director of Accenture Payment Services in Europe, Africa and Latin America. "Most fintech [startups] don't compete with banks. They have relevant technology, but if they don't take liquidity away from banks, they're not competitors."

Light, who advises Accenture clients on payments technology strategy and integration, joined WIRED editors and 20 guests from established and fast-growing companies at Condé Nast's UK HQ. Among them, WorldRemit founder Ismail Ahmed, CH International CEO and founder Liam Casey, technology director of digital innovation at BP Harry Cassar, and Zapp CEO Peter Keenan.

Discussion during the dinner and preceding tech exhibition touched upon the uptake of distributed ledger technologies, and the impending wave of banks releasing APIs. Light anticipates the forthcoming EU Payments Service Directive 2 will "force banks to allow third-parties to initiate payments and see account information," he says. "The only way they can meet that is by releasing APIs, and it's not a natural act for a bank to put an API out – to allow third-parties to play around with their functions and capabilities."

The changes will present big questions about security and liability, and, whereas banks see this as a compliance issue, Light says it's "an opportunity for third parties to spread bank brands wherever consumers need them."

The fintech industry certainly isn't finished evolving quite yet.

For more, see accenture.com/digital

Backup for banks

IN NOVEMBER, WIRED AND ACCENTURE CO-HOSTED THE FOURTH IN A SERIES OF BY-INVITATION DINNER SALONS. THE TOPIC OF DISCUSSION WAS THE IMPACT OF NEW PAYMENTS TECHNOLOGIES ON THE FUTURE OF BANKS, BUSINESSES AND BUYERS

PRE-DINNER NETWORKING

BEFORE DINNER, GUESTS GOT HANDS-ON WITH THE NEW CURVE SMART PAYMENTS CARD, SATOSHI PAY'S NANOPAYMENTS SYSTEM AND ACCENTURE'S AUTOFORMS MOBILE APP



Guy Mason, director of architecture, data and strategy at Sainsbury's, and Chris Booth, head of payment services at RBS, demo the Satoshi Pay system.



Adizah Tejani, head of ecosystem development at Level39, with Ismail Ahmed, founder of WorldRemit, and David Rowan, editor of WIRED and the evening's host.



WIRED deputy editor Greg Williams with Teppo Paavola, chief development officer and GM of new digital businesses at BBVA, and Steve Butcher, CTO, Powa.



Craig Tillotson, CEO of Faster Payments Scheme LTD, with Alick Varma, CEO of Osper, and Jeremy Light, EALA payments lead, Accenture.

CIRCULAR DRINKING

Closed-loop ingredients let you sip this cocktail without worrying about waste

DROPS OF COFFEE OIL

Earthy and bitter. Extracted from used coffee.

52ML COFFEE DISTILLATE

Fruity and spicy. Distilled from old coffee grounds.

210ML BUTTER-WASHED BELVEDERE UNFILTERED

Spicy and nutty.

2.5ML LEMONBALM DISTILLATE

Rich, light citrus notes. Made from used lemon garnishes.

2.5ML LACTIC ACID SOLUTION

Bright, creamy flavour. Extracted from used lemons.

This cocktail was created by upcycling mixologist Ryan Chetiyawardana, whose recipes use bar ingredients typically thrown away after a single use.

PHOTOGRAPHY: SUN LEE

075 / EDITED BY OLIVER FRANKLIN-WALLIS / WIRED CULTURE

MONEYPENNY MARTINI: VAT TOGETHER THE VODKA, LACTIC ACID, COFFEE AND LEMONBALM DISTILLATES, BIRCH SYRUP AND 180ML OF MINERAL WATER. STIR OVER ICE, STRAIN INTO A CHILLED COUPETTE AND DOT WITH COFFEE OIL

You've heard of nose-to-tail dining; mixologist Ryan Chetiyawardana is bringing that same waste-nothing approach to cocktails. The London-based former chef's "closed-loop" recipes upcycle ingredients that bars would traditionally bin. "Say you squeeze a lemon – you're taking

the acidity, the sweetness and some of the flavour and throwing away the bulk of it," says Chetiyawardana, the 31-year-old behind London establishments White Lyan and Dandelyan. "Doing that is completely at odds with the way I would cook."

For example, bars produce lemon husks in abundance: Chetiyawardana's solution is to steep them and make a sweet syrup called falernum, just as he employs his fruit scraps in acetic fermentations. These by-products can then be transformed into entirely new concoctions. At Dandelyan, falernum and vinegar are mixed into a gin sour: "Almost like a compost cocktail, I suppose." He's even working on giving eggshells an afterlife. "It's an edible ingredient. It's not something you're ever going to chew on but you can dissolve it."

This approach is not without its challenges. The menu has to be finely balanced: include too many citrus drinks, and the bar will end up making more falernum than it can use. And he hasn't found new purposes for everything. "Coffee grains and tea bags are difficult. Yes, we do a coffee oil and a tannin tincture from the tea – but it becomes quite weak and you still end up with bulk matter."

Chetiyawardana is known for his experimentation: White Lyan bottle-ages its cocktails and forgoes perishables, and it hosts an ingredients lab where his team experiments with techniques such as fermentation. Dandelyan, on London's south bank, boasts a menu based around botany – each drink is grouped by ecosystem rather than ingredient. But it's never for its own sake. Closed-loop drinks offer cost savings – "a bar has certain margins it needs to make to function" – and ecological value.

He attributes his interest in the latter to his childhood and stories he was told by his mother. "My mum grew up in a big family in Sri Lanka and when they bought a cow they used every last bit of the animal, partly because of their Buddhist upbringing," he says. "My parents instilled it into us to try to be more thoughtful about whatever you're using."

Mixology, he explains, has been transformed. "People [once] treated bartending as something you'd do on the side. So it didn't attract people who wanted to look at things differently. You didn't mess around with the formula."

So how has the rest of the drinks world reacted to his innovations? "When we opened White Lyan [in 2013], people saw it as an insult" – that is, until they tried the drinks. "We had a restaurant critic who came in and said, 'I wanted to hate this, but these are the best that I've ever had.'" **Charlie Burton** mrylan.com

Below: Ryan Chetiyawardana adds coffee oil to WIRED's Moneypenny Martini



Digital extra!
Download the WIRED app for more upcycled cocktail recipes



076 / PLAY / IMBIBING / SURVIVING



NUMBERS 40,000 BEES CAN'T BE WRONG

How many bees does it take to record an album? About 40,000 (and 12 musicians). Wolfgang Buttress' *Be One* was inspired by the dwindling honey bee population. *Out February 12*

WHEN LIFE GIVES YOU LEMONS...



JUICE

A staple for adding an acidic kick to a drink.



LIQUEUR

Preserve in spirits to add a dash of flavour



HUSKS

The shells are used to make falernum.

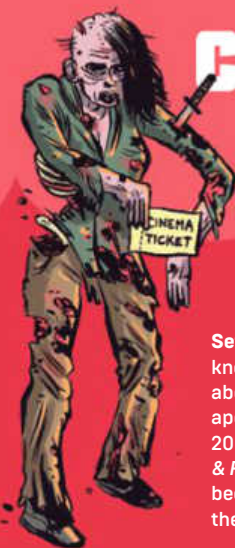


ZEST

Grated, it can be added to sherberts.



PHOTOGRAPHY: SUN LEE. ILLUSTRATION: JAMIE COE, ALEXANDER WELLS



CAN YOU SURVIVE THE ZOMBIE APOCALYPSE?

With *Pride & Prejudice & Zombies* out and *The Walking Dead* back, it's time to prepare

Seth Grahame-Smith knows a little something about surviving the zombie apocalypse. Before his 2009 parody novel *Pride & Prejudice & Zombies* became a viral bestseller, the LA-based author had

written *How to Survive a Horror Movie*, a 2007 comedy tome with tips both practical (never go upstairs) and meta (hide in the deleted scenes). "I prefer my zombies slow and stupid," he says. "I was influenced by George

A. Romero's. The more tragic they are, the funnier it is when they're dispatched by our heroines – beheaded, blown up or burned."

The genesis of *Pride & Prejudice & Zombies* is legendary: Grahame-Smith's editor Jason Rekulak was playing around with titles of works in the public domain ("Wuthering Heights & Pirates; Hamlet In Space") before alighting on Austen, which he pitched to Smith. "It struck me as the best idea I'd ever heard," he says. "I had this image of girls in ball gowns, kicking and fighting. It was incredibly, wonderfully

stupid." The book spawned a whole genre, and a film iteration – resurrected by director Burr Steers.

For Grahame-Smith, it's been a launch pad: he's working on several Hollywood projects, including *The LEGO Batman Movie*, and will soon write and direct a film adaptation of *The Flash*, tying into the Warner Bros' DC Comics universe. "It taught me a great deal about the phenomenon of the zeitgeist, and what's viral," he says. The undead? They never go out of style. *OF-W Pride & Prejudice & Zombies is out on February 12*

Below: the view from the balcony. The maple floor can be reconfigured to suit the performer



NEW YORK'S CUBE OF QUIET

How architects tuned
an entire building
to optimise its audio

This 1,200-square-metre auditorium, which doubles as a recording studio, is built inside the century-old brick husk of a former industrial sawdust factory in Williamsburg, New York. Dubbed National Sawdust and designed by Brooklyn-based architecture studio Bureau V, the venue comprises a thick-walled concrete cube which rests on shock-absorbent springs, creating what architect Peter Zuspan calls an “acoustic envelope” that seals the auditorium in silence. “The space meets the low background noise levels of a high-definition recording studio,” says Zuspan. Inside, a wraparound, translucent skin made from panels of aluminium and speaker fabric allows sound to pass through freely, and also houses audiovisual and electrical systems to create the seamless, modular auditorium space within. Between these two layers, massive curtains can be drawn to precisely tune the sound.

Bureau V, which worked on the project with architecture firm SLAB and the theatre team from London engineering firm Arup, built 3D models to map the auditorium’s acoustic workings: for instance, the angular roof allows the diffusion of higher-pitched notes. Aesthetics also drove the design, with the auditorium’s embellished interior harking back to the 18th-century trend of ornamentation in music chambers.

National Sawdust founder Kevin Dolan wanted the space to become a platform for seasoned artists to perform, as well as a facility where young musicians can record their debuts. The venue, which opened in October 2015, has attracted violinists, opera singers, orchestral players and electronic musicians. “We’re hoping that the egalitarian nature of one intimate space will expose countless new works to the world,” Zuspan says. **Emma Bryce** nationalsawdust.org

CHILDREN OF THE GAMING REVOLUTION

In 2014, the Warsaw-based 11 Bit Studios’ *This War of Mine* showed what a war zone feels like to civilians. Its sequel *The Little Ones*, released last month, adds children to the conflict scenario. “We want to show war as close to reality as possible,” says senior writer Pawel Miechowski, 36. “And, in war, there are kids.”

The Little Ones is a survival challenge, with the game’s *Sims*-like characters struggling for food and shelter in a war-torn city. Problem is, kids – powered by a distinct child AI – will need more than food and a bed. “They are still children who will ask to play with you, and you’ll have to help them forget about war,” Miechowski says. The team were inspired by today’s war theatres such as Aleppo in Syria. “Conflict is a universal thing, and the people’s feelings are the same everywhere.” **GV** 11bitstudios.com



PHOTOGRAPHY: FLOTO + WARNER. ILLUSTRATION: GARETH SCOTT

WIRED Health

29.04.16

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CONFIRMED SPEAKERS INCLUDE



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Hamilton's organs-on-chips could end testing on lab animals



GEOFFREY RAISMAN
His work repairing spinal injuries is allowing paralysed patients to walk



JO MOUNTFORD
Trialling lab-grown blood, which could cut the need for donations and save many lives



LUCY MCRAE
An artist, McRae's work includes speculating on the health needs of interstellar humans



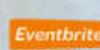
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WITH OUR PARTNERS





DANCING IN A DIGITAL DIMENSION

Daito Manabe's drone troupe blurs reality

Half director, half programmer, Daito Manabe uses technology to bring alternate realities to life.

The Tokyo-based artist programs swarms of drones as both camera operators and mobile props alongside human dancers in his films, combining the real with the imaginary.

"We can project the virtual world on to a real space by using lasers and video – but it is still considered virtual," says Manabe, 39. "But by using drones, what was virtual can now exist

as physical objects." In Manabe's music video for "Cold Stares" by leftfield hip-hop act Nosaj Thing (*pictured*), for example, custom-built quadcopters were used to shoot live-action video of two dancers. This footage was combined with CGI using a technique that involved reconstructing photographs of the dancers over a 3D model, created using motion capture. The resulting film is both jarring and seamless, with the dancers shifting between real and virtual realities so quickly that the line between the two worlds vanishes.

Two real-world actors appear within a mapped digital environment in Manabe's video for NosaJ Thing's "Cold Stares"

"We are constantly experimenting and thinking of ways to create a new form of dance performance by utilising technologies such as machine and deep learning," says Manabe. His latest project is a theatre piece called *Border* that incorporates driverless car technology. "It is not a big vehicle, but rather a radio-controlled wheelchair and self-driving pillars and walls," he explains. Ten members of the audience will sit on stage in the wheelchair-like vehicles, while wearing VR headsets. They will share the stage

with ten dancers – five of them real (visible through an attached camera), and five virtual.

Next, he's bringing his surreal creations to Europe. In March, Manabe is participating in *Transphère*, a series of exhibitions at the Maison de la Culture du Japon à Paris that will deconstruct the future through art. Manabe will show past projects, plus a new interactive installation. It's currently under wraps, but, as with all Manabe's work, you may leave needing to pinch yourself. **Sophia Epstein** daito.ws



The fine art of detecting fakes

When it comes to buying and selling valuable art, falling for a forgery could prove costly. One solution? DNA.

Scientists at University at Albany at the State University of New York want to fight fakes by attaching synthetic DNA to artworks. Each i2M (intelligent integral mark) "sticker" contains a unique biological ID. Adhered to the canvas, it can be read and verified with a scanner, proving a work's authenticity.

Rather than use an artist's own biological material, the technique relies on encrypted synthetic DNA, explains Martin Tenniswood, Empire Innovation Program professor at University at Albany, and creator of the technology. "We asked some colleagues to break the encryption," he says. "Nobody has been able to do it."

The project could solve a problem: not only is spotting fakes hard, but experts are increasingly reluctant to testify for fear of being sued. With \$2 million (£1.3m) in funding from ARIS Title Insurance Corporation, the team is now working with artists and museums on trialling the system. And although the DNA will eventually degrade, Tenniswood thinks that by the time that happens, the tags can be replaced or newer authentication systems will have emerged. "This technology can work for 50 or even 100 years," he says. **GV** i2mstandards.org

SLICKER SLEDDING

Team GB has its sights set on bobsleigh victory in Austria – and F1 tech is playing a key role

Athletes launching themselves down ice-covered concrete chutes at up to 160kph sounds reckless, but bobsleigh is an exacting science. “At Sochi [during the 2014 Winter Olympics], we were 0.11 of a second off a medal,” says Gary Anderson, performance director of British Bobsleigh. So, when Team GB takes to the Olympic run in Innsbruck, Austria, for the World Championships on February 8, every advantage counts.

In competition, Team GB will deploy three new craft, each designed using aerodynamic techniques akin to those used for Formula 1 cars. During a practice run, or *lauf*, Anderson’s team collects data – “speed, angle of the sled, g-force” – that could make a difference. The pilot and crew then need to steer the sleigh down the run with tiny, ultra-fast corrections. “I’ve never been this excited about a World Championships,” says Anderson. Here, he talks us through a winning *lauf*. **OF-W** thebbsa.co.uk

1. THE ATHLETES

Bobsleigh teams (either two- or four-person) need speed and strength, plus body mass. “We built a profile,” says Anderson. “A sprinter needs to be running 100 metres in 10.3 seconds and weigh 95kg to 104kg.”

2. THE START

This is all about building maximum momentum. Innsbruck is 1,100m and very fast. “With the shorter tracks, the velocity at the start has a bigger contributing factor than longer ones,” says Anderson. The run-up lasts six seconds.

3. TURNING

The sleigh is steered down the run using D-rings. In fast turns, athletes can experience up to 5 g in lateral forces. Pilots practise each run using simulators and point-of-view video to find the optimal racing line.

4. THE SLEIGH

Bobsleigh specs are tightly regulated: when empty, a four-person craft can weigh no less than 210kg. The chassis is carbon fibre with steel runners. Team GB has three craft, each by different manufacturers: the

hull and runners are chosen during preparations before the event. The hulls are designed using wind tunnels and computer simulation to reduce drag and vibration; runners are optimised to reduce friction.

5. THE FINISH

Throughout, on-board sensors send data to broadcasters and race officials. Then it’s time to hit the brake – which, at such speeds, can be tricky. After all, when speed is the goal, who cares about stopping?



T

hough it creases and flows like satin, this dress was 3D-printed in plastic. The gown was created by Massachusetts-based design studio Nervous System. Founded by Jessica Rosenkrantz and Jesse Louis-Rosenberg, the studio experiments with new ways to use 3D printing to design fluid materials.

Each dress starts as a 3D scan of the wearer's body. Kinematics software breaks the design down into thousands of differently sized triangles, then adds hinges to each segment. Developing the software required months of simulations. "We tried a number of physics engines," says Rosenkrantz, 32. "A lot of them just didn't hold up."

The dresses are fabricated as a single piece using a Shapeways selective sintering machine (cheaper printers can't form the hinges) and unfolded, cleaned

and dyed. The process takes two days. "The garment has a lot of movement," says Louis-Rosenberg, 29.

The idea began as a vanity project. "A lot of our work is research-based, but many of the things we make are things I wanted for myself," laughs Rosenkrantz. "Ultimately, I wanted a really cool dress."

The studio has printed nine Kinematics dresses – the first was acquired by Moma. It will ship made-to-order versions, starting with a smaller skirt, in early 2016 – although they won't be cheap ("like an expensive wedding gown"). For an affordable fix, the studio created an app that lets you design Kinematics jewellery, and is working on a collaboration with New Balance. "Ultimately, we're not just creating a project, we're creating a system," says Rosenkrantz. Does anyone know a silicone seamstress? **OF-W** n-e-r-v-o-u-s.com

A smoother swaying dress



To optimise printing, the software folds the design down into the smallest possible shape

ICE RIDERS / FLEXI FASHION / CHEAT EATS / 083

DON'T EAT THAT!



Did the horsemeat scandal kill your appetite? In *Sorting the Beef from the Bull: The Science of Food Fraud Forensics* (Bloomsbury Sigma), out February 25, Richard Evershed and Nicola Temple chronicle the disturbing, widespread – and, admittedly, often ingenious – fake-food industry. Their advice to us: always read the label, but don't necessarily trust it. **OF-W**

FAKE EGGS

Cropping up in China since the 90s, they're made from a mixture that includes sodium alginate, gelatin, lactones, paraffin wax and plaster (for the shell).



FAKE MILK

Milk is often watered down or bulked up in poor countries. But in India, fake milk has been found containing oils, caustic soda and even shampoo.



FAKE SPICES

Adulterated spices range from the gross (chilli powder bulked with brick dust) to the toxic: in 2014, allergenic nut shells were found in cumin in the US and UK.



ADRIFT challenges players to escape from a devastated space station. But the VR game, which is due to launch alongside Oculus Rift in early 2016, has its origins a little closer to home. Adam Orth, co-founder of indie developer Three One Zero, had the idea when his own world blew apart. An unguarded Twitter comment led to outrage, threats and his resignation from Microsoft Game Studios in 2013. "I was basically in hiding," says Orth, 45. "Adrift was a great word for how I felt." The experience, which pre-dates the similar 2013 film *Gravity*, inspired Orth to emerge from hiding and began recruiting.

The space station's aesthetic was inspired by *2001: A Space Odyssey*, minimalist architecture – and

Braun's 70s KF21 coffee machines. "We were careful about how we destroyed the space station," says Orth. The player has to hunt for oxygen and navigate through ruined sections while trying to discover the cause of the accident. It's zero gravity, so the only limits are the player's own comfort and the need to replenish air supplies. "You can go in any direction," says Orth. "You can even play upside down."

ADRIFT's astrobatrics were built from the ground up for VR. And, just like the astronaut, Orth is in unfamiliar territory. "Things are moving fast," he says. "It's so exciting to explore the unknown." **Daniel Nye Griffiths** *ADRIFT* will be released for PC in spring 2016. threeonezero.com

ADRIFT's protagonist has to determine the cause of the space station's destruction

HOUSTON, WE'RE GOING TO NEED A MOP UP HERE

ADRIFT lets you experience zero gravity while on terra firma



Cook back the years

The "one ingredient that prevents ageing" may just be clickbait, but Maria Kononenko thinks what you eat could extend your lifespan. "We can cook longevity," says Kononenko, a PhD student in the biology of ageing at the University of Southern California and the Buck Institute for Research on Ageing.

Kononenko's *Longevity Cookbook*, scheduled for publication in 2016, explains how we can slow the ageing process with food. Think fewer cure-alls, more behavioural hacks. "Nutrition regimes, such as caloric restriction, that have been scientifically proven, modulate ageing," Kononenko says. She points to experiments showing that a 30 per cent reduction in calories can increase a mouse's lifespan by up to 40 per cent.

Although the first chapters include these dietary measures, Kononenko is still gathering the book's recipes. One banned ingredient: excess protein. "One big misconception is that protein-rich diets are good. But in the long term it can lead to increased cancer risk."

Any good news? "Olive oil," she says. "It seems to be wonderful."

Kathryn Nave
longevitycookbook.io

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& 10 DIGITAL EDITIONS. OFFER CLOSES ON 08/03/2016.

▼ WEST COAST WIG OUT

San Francisco-based Thao Nguyen – aka Thao & The Get Down Stay Down – makes post-internet funk-folk. New album *A Man Alive* mixes distorted electronic effects and fuzz pedals, influenced by producer Merrill Garbus of tUnE-yArDs. *Out March 4*



▲ EXTREME FILM-MAKING

Ericson Core's reimagining of the 90s surf classic *Point Break* dials up the stunts. The crew hired world-champion wingsuit pilots and climbers, among others, and filmed scenes using GoPro rigs. *Gnarly. Out February 12*



Playlist

► DESCENT INTO MADNESS

Set in Volterra, a real Italian asylum closed in the 70s for cruelty, *The Town of Light* offers a different take on horror-gaming. A disturbingly real insight into psychological trauma. *Out Feb 26 on PC and Mac. thetownoflight.com*



▲ BACTERIAL BLOSSOMS

In *Subvisual Subway*, Brooklyn-based artist Craig Ward took bacteria from the New York Subway and grew them in Petri dishes. Beautiful, but dangerous: among the nasties are *E. coli* and *Salmonella*. *wordsarepictures.co.uk*



086 / PLAY / CULTURAL PICKS OF THE MONTH / 03.16

► STORM WARNING

Lauren Redniss's *Thunder & Lightning: Weather Past, Present, Future* (Jonathan Cape) looks at Earth's climate. Her approach – stunning reporting, combined with evocative artwork – gives the book a gale-force impact. *Out February 4*



▲ COMIXTRIP

Diversity in comics is hot right now, but it's not necessarily new. In *Comix Creatrix*, London gallery House of Illustration chronicles 100 women artists and authors from the 18th century to present day. *From February 5. houseofillustration.org.uk*

the gadget show

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WHAT HI-FI?
SOUND AND VISION

**HOW IT
WORKS**

FOCUS
MAGAZINE

Gadget

Events, new products and promotions to live the WIRED life

Compiled by
Cleo McGee



1/Chanel Coco Mademoiselle eau de parfum

This fragrance for her is a fresh, citrus-based scent with hints of jasmine and rose. Delicate and feminine, the eau de parfum comes in a spray format for effortless application. Bath and body products are also available to complete the perfuming ritual.
From £68
chanel.com

2/North Sails double hood jacket

Made using Japanese fabric from Daiichi Orimono, this unisex jacket is lightweight, windproof and features remarkable water repellent properties. Seam taped at crucial points, its spray-proof coated zippers add even more protection. It also incorporates a Tyvek coated double hood.
£235
northsails.com

3/American Express Corporate

American Express provides Corporate Card, Corporate Purchasing Solutions and other expense management services to companies and corporations. It is a leading issuer of commercial cards, serving more than 70 per cent of the *Fortune* 500 and thousands of SMEs.
americanexpress.co.uk/corporate

4/SMEG pastel blue blender

This Smeg appliance features an 800W motor for superb blending. It also has four speeds, a pulse button and two pre-set functions for smoothies and ice crushing. The blender comes in a choice of seven colours for perfect kitchen co-ordination.
£149.99
smeguk.com



WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED HEALTH

WIRED Health is back with a new roster of speakers. Hosted at 30 Euston Square, the day will have a Main Stage and a Startup Stage, as well as a hands-on tech lab. As with any WIRED event, there is an emphasis on networking with leading individuals in the sector.
April 29, 2016
wired.co.uk/health16

WIRED MONEY

WIRED Money returns to the iconic British Museum in June, welcoming a variety of companies and speakers – from major players in the finance world to investment potentials on the Startup Stage. Meet and network with the sector's most disruptive and diverse influencers.
June 23, 2016
wired.co.uk/money16

MORE WIRED EVENTS

WIRED's flagship two-day event returns in October, along with our one-day experience for young minds. Plus WIRED Retail will be back for a third year in November. In addition, we are announcing two new events for 2016: WIRED Security and WIRED Energy. As always, WIRED endeavours to cut through the hype and deliver carefully curated stages, showcasing people making a tangible difference. Networking is paramount at our events and as such they are set up to allow for maximum social engagement. If you want to be ahead of the curve – as well as the competition – WIRED events are essential dates for your 2016 calendar.
Dates TBC
wired.co.uk/nextevent

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* BUT WITH FOOTNOTES. ILLUSTRATION: ROBERT G FRESSON



OFF-PLANET PSYCHOLOGY

THE INNER-SPACE EXPLORER

Alexander Kumar is helping scientists prepare for life on Mars – by observing their psychological decline in the loneliest place on Earth. By Nayanah Siva

IN FEBRUARY 2012, A VINTAGE DC-3 BALSER AEROPLANE TOOK OFF FROM AN ICY RUNWAY IN ANTARCTICA, NOT to return for nine months. The drone of the plane's engines faded into the cold winter sky, leaving a crew of 13 behind on the ice, including meteorologists, glaciologists, climatologists and astronomers. They were at the coldest point on Earth, where temperatures drop to -80° Celsius, and winter consists of three months of darkness. Their destination: a French-Italian research lab, Concordia Station, which would be home to them for a year. >

To one of the scientists, British medical doctor and explorer Alexander Kumar, each breath felt like the air was being ripped from his lungs¹. Sixteen thousand kilometres from home, he trudged to the station with his new housemates, wondering what might to get him first: the severe cold and hypoxic conditions, or the deep isolation? But that was the point of his "White Mars" study for the European Space Agency (ESA).

"You can go mad there. People go off the charts," Kumar says. He splits his time between the University of Leicester, where he undertakes clinical and research work in infectious diseases, and the University of Fribourg, Switzerland, where he is completing his PhD on extreme physiology and psychology.

We hear of the physiological challenges of space travel: bone loss, altered cardiac rhythms, decompression illness, changes in vision. But a lingering worry for space agencies has been astronauts' mental health, which has been known to impact the success of missions. It is rumoured that at least three Russian space missions were terminated due to psychological and interpersonal issues among the crew².

Kumar wants to understand how far human physiology and psychology can be pushed under such extreme conditions, in preparation for a future manned mission to Mars. "Physiology we know about – it's easy to predict the effects," he says.

"Psychology is fascinating because it's largely unpredictable." According to Kumar, ten per cent of people who winter in Antarctica will develop serious psychiatric problems. His experiments at Concordia built on previous ESA work, which found that despite all the screening, training and preparedness for a mission, the isolation and extreme conditions deeply impacted cognition. Effects include dysfunctional responses

to stress, fatigue, lack of energy, conflicts and tensions, perceived loss of control, and decrements in attention and cognitive function³. "It is extremely difficult to predict who will not do well there," says Kumar. Choosing people who are good at coping with stress does not seem to make a difference. The symptoms impact anyone and everyone – even Kumar. "You never know what monsters sleep undisturbed in the unexplored corners of your mind," he says.

It's possible to quantify and measure these psychological factors. Some of Kumar's experiments required testing blood, urine and saliva, and wiring the crew up to electroencephalogram machines to assess brain activity as they performed tasks, such as playing brain-teaser games. By doing so, he was able to chart the decline of the crew's mental wellbeing. Effects included difficulty and slowness in concentration, and short-term memory problems.⁴ "People do become cognitively impaired during the Antarctic winter, and we would also expect this on a nine-month flight to Mars," Kumar says. "By the time the crew get there, they will have to perform one of the most technologically difficult landings in aviation, space and human history."

In addition, Kumar points to a recent study where actual structural changes in the brain were reported in those who wintered in Antarctica. In a Nasa-sponsored study undertaken at the German Neumayer Antarctic station, Mathias Basner from the University of Pennsylvania and his team performed MRI scans of crew members before, during and after their mission. Surprisingly, they found physical loss of volume

to the hippocampus in the brain, which is essential in both memory formation and visual and spatial orientation. "One of the biggest issues people complain about during the winter is specific memory difficulty," Kumar says. The next stage is to perform MRI scans on the current crew at Concordia, due to leave in November and December 2015⁵.

Another aspect that was profoundly affected was sleep. Kumar tracked his team's circadian rhythms by measuring levels of cortisol and melatonin in urine and saliva over 24-hour periods. He also noticed a distortion in the crew's perception of time, and assessed oxygen levels and sleep patterns. Nightmares were commonplace, but Kumar says this could be explained with physiology. The altered day-cycle, months of darkness, sensory deprivation and a hypoxic environment all contributed. At times, the crew members' oxygen saturation was dangerously low during sleep, at levels below 83 per cent, compared with 95-100 per cent for someone living at typical altitude. Taking less oxygen may be accompanied by hypercarboxemia, where the level of carbon dioxide in the body is removed less quickly due to the lowered respiratory rate and gas exchange⁶. This rise in CO₂ can impact blood pH and cerebral blood flow, which affects sleep and dreams.

Kumar has been surprised by findings that quantitatively showed that the detrimental effects of isolation may be more than that of physiological factors such as hypoxia. Psychological stress may impact the brain as much as, if not more than, physiological. As he wrote on his *New York Times* blog: "Living in isolation, exacerbated by sensory deprivation, I have often woken feeling exhausted, like I had already lived the day ahead, having spent the night on a nerve-racking, adrenaline-fuelled rocking horse adventure in a desert or jungle, surviving one of Antarctica's many conjured nightmares."

Choosing people who are good at coping with stress does not seem to make a difference

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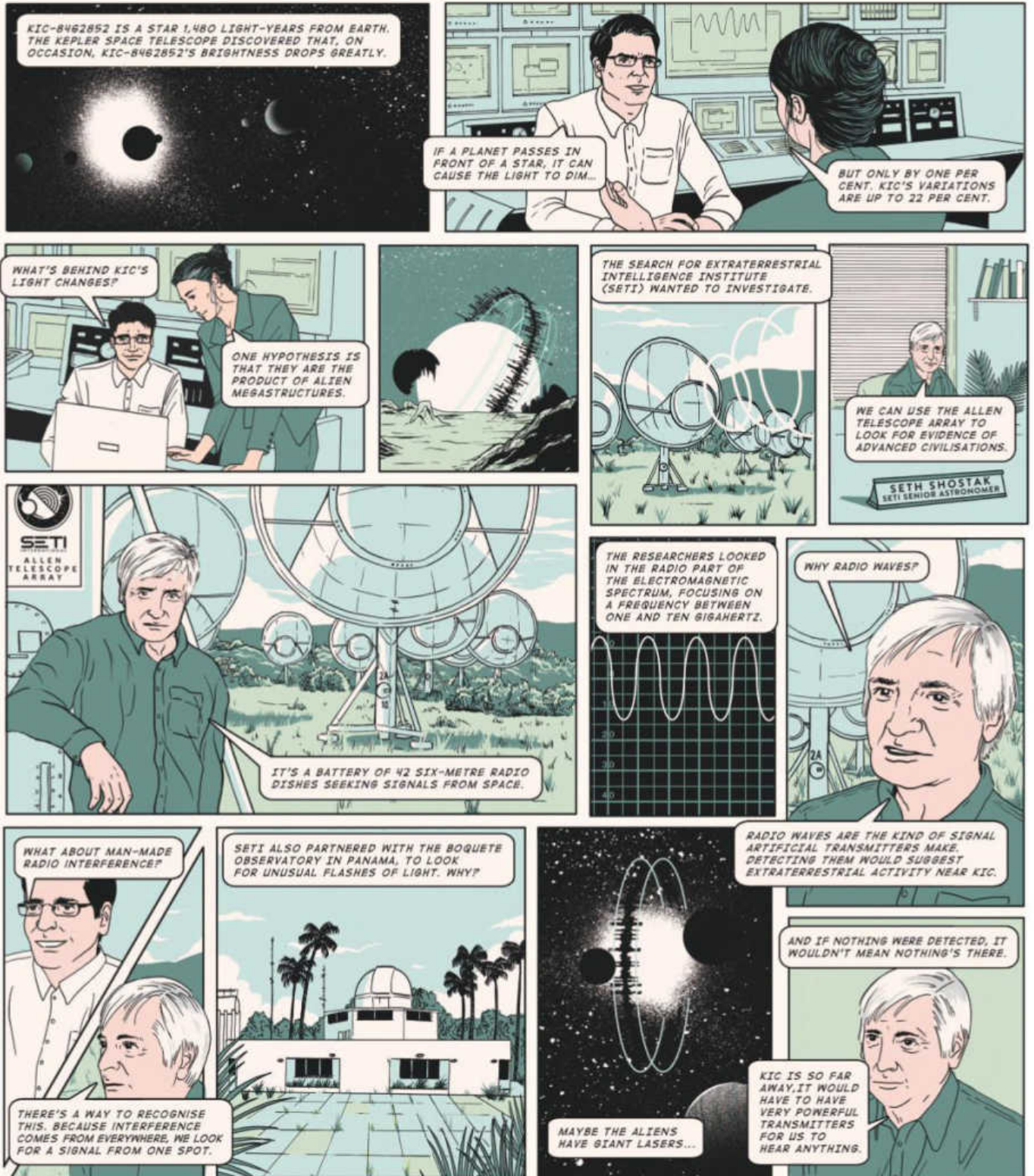
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SETI'S SEARCH FOR LIFE

Each month we illustrate today's pioneering projects.

This issue: how scientists at the Search for Extra Terrestrial Intelligence (SETI) are seeking evidence of a massive alien megastructure built around a star showing unusual light fluctuations





Harvard University's Lisa Randall is a theoretical particle physicist focusing on extra dimensions of space and dark matter. In her fourth book, *Dark Matter and the Dinosaurs* (out now, Bodley Head), Randall explores the interconnectedness of the universe, theorising that dark matter may have caused Earth's major extinction event 66 million years ago.

Researchers suspect that as our solar system orbits the Milky Way's centre, it bobs up and down through the central galactic plane about once every 35 million years, roughly matching the frequency of comet impacts on Earth. Randall's twist on this idea: dark matter could be clumping together to form a dense "dark matter disk" at the centre of the Milky Way's galactic plane. As our bobbing Solar System encounters this disk, its gravitational pull yanks on comets, dragging them toward Earth.

WIRED talks to Randall about this new theory, the evidence, and why it's OK if your ideas are overturned.

WIRED: How do you explain dark matter – and is it really “dark”?

Lisa Randall: Well, first of all, it is just matter. What do we mean by matter? Something that kind of clumps; it's defined by how it interacts under gravity. So dark matter is like the matter we know about, the stuff we see around us. The big difference is there's no interaction with light that we know of. That makes it different from the point of view of what we see, but not from the point of view of how gravity acts on it. In some ways, I think it would have been better if it had been called transparent matter, because light just passes through it. It's not made up of the stuff we're used to. It's something different; we don't observe directly with our eyes!

What's different about your theory of dark matter?

As the Solar System goes round the galaxy, it bobs up and down through a plane in the Milky Way. If there is a dark disk, at some point, when it goes through in the mid-plane, there will be an enhanced gravitational force that could conceivably knock comets out of the distant Oort Cloud, where they're very weakly bound. Before our work, people had suggested that as the Solar System goes up and down through the Milky Way, comets get dislodged. The problem was that there was nothing that was abrupt enough to explain why you get a spike in comet strikes. It was too continuous and too smooth. The dark-matter disk solves these problems.

And the idea of interacting matter is important, because it explains how the dark matter would clump to form a disk?

That's right. I think that, if nothing else, this idea that there could be a fraction of the dark matter that interacts will probably survive. Just like ordinary matter comes in many different types, some of which interact in very different ways, maybe there's a small fraction of dark matter that interacts with itself. We realised that if there is an interaction, it could have very important and measurable implications.

The Gaia satellite is currently out in space, mapping the density of the Milky Way: could it provide evidence for your theory?

One of the really great things was we realised that the Gaia satellite – which was about to launch in the autumn after we finished the dark-matter research – was going to do exactly the measurement we wanted, measuring the positions and velocities of stars, and from that, we'd be able to figure out what their galactic potential looks like. That will tell us whether there's a dark disk with the right properties at the very least. There are other conceivable implications, but this one is most directly measuring whether there's a dark disk².

Will the Large Hadron Collider give us further clues about dark matter?

There is a possibility that dark matter can be searched for at the Large Hadron Collider, if it has mass that's comparable to that of the Higgs boson. There's a built-in assumption there, that there's a tiny interaction called the Standard Model Interaction. If there is a tiny interaction, there's a possibility that it can be produced at the Hadron Collider and disappear in the form of what we call “missing energy”. We'll eventually figure out, was there dark matter present or not? It's going to be hard to determine, even if you found something like this that is indeed dark matter. But you can measure its properties and from that conclude whether it could play a role.

Q & A

DARK THOUGHTS

Harvard theoretical physicist Lisa Randall tells WIRED how the undetectable matter may have helped to wipe out the dinosaurs



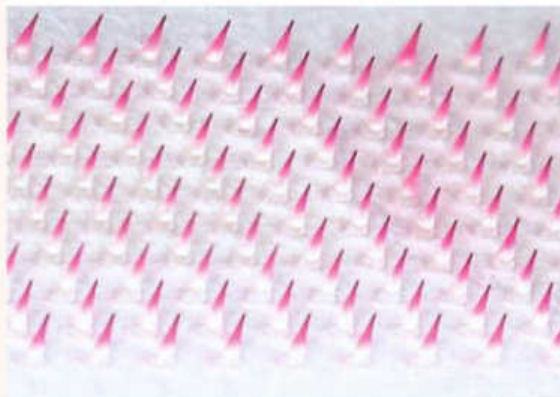
Do you worry that new evidence might overturn your theories?

Oh no, I think that's fantastic. It's kind of like going to the doctor if you're sick: if you know something is wrong, you can do something about it. If we find out the idea we were pursuing is wrong, well, we'll look at some other idea. It's good to be able to narrow our focus to the ones that have a promise of being right.

What are you researching next?

We're working on a completely different idea with James Unwin and Jakub Scholtz. We're not only thinking about double-disk dark matter, but all of the dark matter. When we have models of dark matter, we often assume that somehow it is related to ordinary matter, despite the absence of any evident interaction. So we're saying, suppose dark matter and ordinary matter start off on unequal footing – what would we need to accommodate what we see in the universe? Can it help us understand even the structure of small galaxies? We're approaching dark matter from very different angles. **Emma Bryce**

1. In her book, Randall wanted to overturn preconceived notions about dark matter – for example, that it's equivalent to black holes. In fact, the two are “no more alike than black ink and film noir”. 2. Randall makes it clear that her theory about dark matter is speculative – at least for now. Still, she explains, it gives us an opportunity to explore more about our galaxy and what it's made of.



5mm

VACCINE PATCHES

IMAGE OF THE MONTH

Need to administer a vaccine, fast? Researchers are developing a slap-on patch for rapid immunity

These 0.7-millimetre microneedles can rapidly deliver vaccines into the body. Developed at the Georgia Institute of Technology, the polymer-sugar points are loaded with a vaccine (represented by pink dye in the image). Self-administered on to the skin via a sticking-plaster-like patch, the spikes dissolve within minutes, releasing their contents into the body. **EB**

BIOMATERIALS

What might we achieve with materials that behave like living things? That's the question driving biomaterials scientists, who investigate ways in which man-made substances might be influenced to imitate nature. The field holds **special relevance for areas such as medical research.**

Medicine, made to order

Bio-inspired materials deployed at the nano scale will enable truly personalised healthcare

Current projects include developing smart materials that can perform sophisticated functions, such as targeted drug delivery, tissue regeneration and self-assembly in the body. “We're trying to create biomaterials that can interact with the surrounding

tissues,” says Helena Azevedo, senior lecturer in biomedical engineering and biomaterials at Queen Mary University of London.

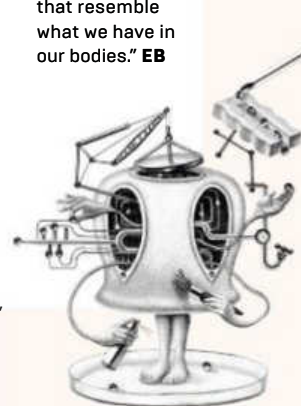
For example, researchers are engineering drug-carrying nanoparticles to deliver treatments via the bloodstream to precise locations in the body. Achieving this requires

manipulation at the molecular scale. “We can decorate these nanoparticles with the specific molecules that are recognised by certain cells,” says Azevedo. Those molecules then provide instructive cues that steer the particles towards the tissues where

drugs are needed.

This technique has the potential to transform personalised medicine, Azevedo claims. Future treatments could use smart, bio-inspired particles to deliver drugs in predetermined quantities to specific sites, and at particular times, all designed to match a patient's unique medical requirements.

“It has been very difficult to replicate nature, but we are taking little steps and increasing the complexity,” says Azevedo. **“There are already biomaterials that resemble what we have in our bodies.” EB**



WIRED

IT'S TIME TO

APRIL ISSUE OUT MARCH 3

COPY CHINA



**HOW COMPANIES FROM DJI TO XIAOMI
ARE RE-IMAGINING THE TECH BUSINESS**

FEATURES



ILLUSTRATION: PETER JUDSON. DRAWN IN ADOBE ILLUSTRATOR USING THE SNAP TO GRID TOOL TO CREATE A FORCED DEPTH AND PERSPECTIVE

"I knew that the cooking was good, but it wasn't our own." René Redzepi, p96

Noma's taste of



RENÉ REDZEPÍ'S RESTAURANT IS OFTEN VOTED THE WORLD'S BEST.
NOW HE WANTS TO BUILD A GLOBAL MOVEMENT AROUND FERMENTATION, FORAGING – AND A READINESS TO FAIL
BY GREG WILLIAMS. PHOTOGRAPHY: AORTA

tomorrow



Noma chefs in the restaurant's prepping room



ON THE MENU

Over the next six pages, photographers Aorta celebrate three classic Noma dishes in still life

ROASTED WILD DUCK

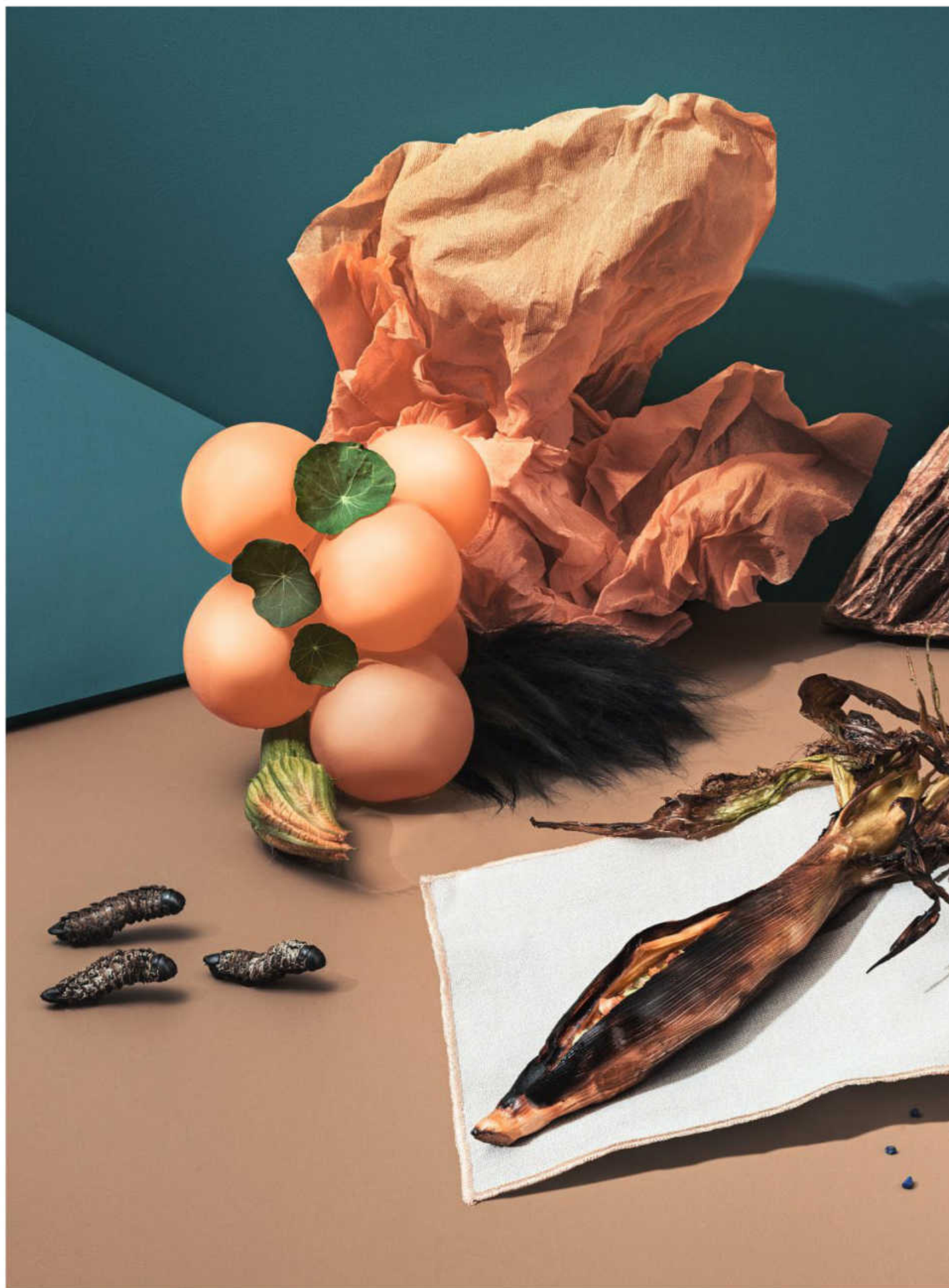
Wild Danish duck is grilled and glazed until it is cooked through. The glaze is made from water, fermented rye bread and smoked butter





FOREST FLAVOURS AND CHOCOLATE

Finnish reindeer moss with pine salt covered in chocolate; lemon verbena covered in chocolate with blackcurrant powder; fermented cep mushroom covered in chocolate with raw liquorice; oxalis covered in chocolate with verbena powder





GRILLED BABY CORN WITH CURED EGG YOLK

Baby corn from
Noma supplier Søren
Wiuff, brushed with
an egg yolk and beef
marinade, and served
with kelp oil, lemon
thyme and smoked salt

O

ne autumn afternoon in 2015, Danish chef René Redzepi is thinking hard about his restaurant's place in the world, both philosophically and geographically. "People consider Noma to be a local restaurant," he says. "We might be culturally local, but 'local' in terms of food miles – what does that mean? There are no definitions of these things. According to some 2008 Farm Act in America you have to source within 400 miles, which is like 650 kilometres, which makes us actually a Polish restaurant as well."

Redzepi, a youthful 38-year-old with a sweep of floppy brown hair, who bears a resemblance to the comedian David Mitchell, is sitting at the corner of a long table up a flight of stairs from his restaurant, Noma, which is located in a former 18th-century warehouse remodelled in 2011. The waterfront neighbourhood in central Copenhagen reflects its maritime heritage: the warehouses once stored salted fish, whale products, oils and skins from the entire north Atlantic region.

The space, known as the Food Lab, was designed by Danish architects

3XN, and contains an office space with modular furniture, a hydroponic herb garden (nasturtium, lemon verbena, St John's wort, lavender) and seating for staff meals. Redzepi wears chef's whites and a black apron. When he talks, he layers thought after thought, linking them carefully and building rounded, considered answers.

He has been a playful presence throughout the day (Redzepi has a talent for mimicking accents – his cockney is more Danny Dyer than Dick Van Dyke), as waves of people have passed through the space. Interns, who listen to death metal and hip hop while breaking down the raw products that arrive at the restaurant, come from the prep kitchen next door to sit and eat (the meals are less expansive than you might imagine – cheese on toast for lunch, poached fish and salads for dinner). Around 3pm, foragers who scour the coastline and woodland sourcing the seasonal products that are intrinsic to Noma's identity –

scurvy grass, samphire, pea shoots, beach mustard, purslane, beach beets, sea arrowgrass – arrive carrying large plastic baskets that have been emptied in storage sheds downstairs. Throughout the afternoon, groups of well-heeled diners are given tours of the Noma facility, snapping photos of the test kitchen, which turns out six new dishes per week (each dish taking 80 to 90 hours to develop). The herb garden fills the room with an earthy, organic smell. There is a large rack of shoes by the door – everyone at Noma puts on Birkenstock clogs when they enter the workspace.

When Noma opened in February 2003, the restaurant's philosophy was that the food should be based on the geography from which it was being sourced. The notion was complicated and had limitations for an ambitious chef who was interested in creating something entirely new. Redzepi didn't want to take ingredients and simply adapt them to existing recipes, yet this



Arielle Johnson, head of research at MAD, in the fermentation lab at Noma

was what was happening in his kitchen. “I knew that the cooking was good, but it wasn’t our own,” Redzepi says.

Noma was voted the world’s best restaurant by *Restaurant* magazine in 2010, 2011, 2012 and 2014. During this time, a new sensibility began to emerge. The team began to realise that they had been constricted. To do something original they were going to have to break away from the format of the western tasting menu, which remains largely unchanged throughout the year. As Lars Williams, the chef who heads Noma’s R&D, says: “When Noma opened 12 years ago, it was a laughable idea that you could make a gastronomic restaurant with Nordic ingredients: if you were a high-end restaurant you had to have French pigeons; you had to have foie gras; you had to have caviar. To think that you could make a compelling restaurant with the local ingredients that we have here was a joke.”

Noma struggled to find what it needed during the freezing Nordic

winters. Onions would have to be sourced from Stockholm or Hamburg, which are, respectively, 700km and 300km away. However, there were other ingredients that were – and are – plentiful. “This is the time when fish are abundant,” Redzepi says. “The flesh is the most firm that you can imagine, their bellies are full of roe and all the other innards are pristine – the liver, the milk and so on. It’s also the moment when all of the shellfish is at its best – bucketloads of urchins, oysters, weird clams, weird penis-looking shells. And it dawns on you, why don’t you just focus on that? Why aren’t we then – at that period – a fish restaurant? Why don’t we just cook what’s there?”

The chefs started to look at the flow of ingredients through the months and shifted the menu towards seasonality and locavorism, which characterises every aspect of Noma, from its food to tableware. Redzepi believes that this approach is “going to drive all the questions within food going forward”.

The service kitchen has been rearranged to reflect this: a traditional kitchen is structured along the classic French brigade to cuisine system, a hierarchical approach in which specific chefs have responsibility for sauces, fish dishes, grilling, roasting etc. Noma’s kitchen is more fluid, reflecting a different type of work, the preparation of the veg, roots, herbs and fruits that form the basis for the majority of the menu. Remodelled in 2013, the work areas, made of simple black monoliths, resist the rigidity of many kitchens. Each chef must know how to make and plate every dish. No one speaks – it’s impossible to be heard over the music anyway. Tasks are accomplished with a brisk, raw energy that verges on mania.

Grilling is done outside on a charcoal-fired Weber Kettle, which Noma prefers over roasting or a sauté pan: “You get a smokiness to the flavour and much more umami,” Williams says. Both proteins and vegetables are cooked on the grill, the latter with smoked butter, to make them umami-rich. The grill is fired up at around seven in the morning and runs until around 11 at night. Noma gets through three of them per month.

Early in the day, dishes are partially assembled. Some of the work is done

with medical-grade tweezers and other instruments familiar to those who perform surgery. The plating process at Noma is particularly complex with multiple items – grilled vegetables, slivers of fish, foams, herbs, grated roe, sauces, vinegars, berries, mosses, rocks – being layered on top of each other and arranged in colourful displays that are part dinner, part landscape.

Redzepi likes to create surprises that provoke curiosity and wrong-foot visitors. Spoiler alert: what looks like a floral arrangement when diners sit down at the table is actually an appetiser. His dish “the hen and the egg” requires visitors who have prevailed over Noma’s notoriously challenging reservation system (it might actually be easier to win a Nobel Prize) being asked to crack a wild duck egg on to a skillet heated to 280°C and laid on a bed of damp straw.

“The whole basis of what we’re doing is the quest for flavour and for deliciousness – that’s our mantra, if we have one,” Williams says.



The dining room at Noma

The notion of experimenting with what food could be and how it might be prepared is the job of Williams and his colleague Arielle Johnson. Williams, a New Yorker who perpetually sips black coffee from a tin mug, wears chef’s whites with three pens in the top pocket and black jeans, and has the first 15 lines of John Milton’s *Paradise Lost* tattooed on his forearm (“Of man’s first disobedience, and the fruit/ Of that forbidden tree, whose mortal taste/ Brought death into the world, and all our woe...”). Before Noma, he and his Danish wife spent a year as private chefs on a boat in the Pacific after meeting at Heston Blumenthal’s Berkshire restaurant The Fat Duck. (Williams also did a stint at chef Wylie Dufresne’s legendary wd-50, New York’s most celebrated destination for molecular gastronomy.)

Arielle Johnson is head of research for Noma’s food symposium MAD

“Fermentation is a kitchen tool in the same way that a frying pan might be”

Arriving at Noma in January 2009, Williams first worked in the kitchen. A year later, Redzepi asked him to take over the Nordic Food Laboratory (NFL) a food-research project that was once a joint venture with the University of Copenhagen. The two have since separated. At that point, NFL was in a houseboat in the harbour next to the restaurant. Its task: to find innovative ways to use Scandinavian ingredients. Williams had been working with wood ants that are found about 25 minutes' drive from the restaurant, investigating various possibilities for flavour and taste. He had found one species in the woods near Copenhagen that had a powerful ginger-lemongrass flavour and was interested in finding out why the ant tasted that way. After trawling through patents and academic papers he had discovered a document that illustrated the chemical structures of different ant pheromones and how they relate to flavour. But then he had hit a dead end. He was puzzling over the diagram on his desktop when Johnson, who was working at the lab for the summer while completing a PhD, came by and examined the screen.

"What are you looking at lemongrass for?" she asked.

It turned out that ant pheromones are made of the same molecules that are found in lavender and pine as well as lemongrass.

"Most social insects have some sort of pheromones, but ants seem to have the widest range of flavours," Williams says. "The ants that we use most in the restaurant at the moment create a sort of acid that's very lemon-flavoured as a defence mechanism. But they have the capability of producing a very wide range of flavours – orange, coriander or mint."

Working at the Food Lab is best suited to those who are omnivorous. Williams and Johnson have just come back from a trip to Zimbabwe during which Johnson developed gastric problems – she's not sure whether it was caused by well water or goat intestines. Despite tasting whatever was at hand, Williams remained in rude health. "It's my job to eat a wide range of microbiomes," he says, "so I have a rather robust digestive system." Later, he recalls a foraging trip in the woods in Japan. "What's this?" he asked Johnson, holding up a berry he had just tasted. Johnson identified it immediately as the fruit from black nightshade, a highly toxic flowering plant. Williams suffered no ill effects.

One morning in May 2015, Johnson and Williams are demonstrating

Noma's zero-waste composting machine, made by Australian company Closed Loop, which breaks down 100kg of food waste into 10kg of compost in just 24 hours. Williams admits that he's tasted the compost.

Williams: "The composter works using lactic bacteria."

Johnson: "Yes, it's like a thermophilic lactic bacteria, which is the

'IT'S MY JOB TO EAT A WIDE RANGE OF MICROBIOMES, SO I HAVE A RATHER ROBUST DIGESTIVE SYSTEM'

same genre of bacteria as in sauerkraut. It's very salt-tolerant and very heat-tolerant and very difficult to kill."

Williams: "And it digests anything you put into compost within 24 hours. I was actually a little bit nervous about eating that."

Johnson [after Williams ate the compost]: "We were looking up all these papers about it to try to figure out what the thermal death curve of it was."

Williams: "And also, once I ate it, would I eat it – or would it eat me?"

Much of the energy in the Food Lab is put into fermentation. Scandinavia has a strong history of foodstuffs being altered for preservation by yeast and bacteria. The time period for the warmer months is extremely short and there's a period of high botanic growth, "this burst of vegetation and flavours that you really need to find some way to preserve to make sure you have something to eat," Williams says.

The Food Lab was conscious that preserved fish and meat were often heavily smoked or salted and the pickling was overly acidic. The team decided to start playing around with fermentation, but focused on flavour, as opposed to how long a product could sit around on kitchen shelves. Asia, specifically Japan, is a significant influence. "With basically rice and soya beans and a thousand years of cleverness, they have fermentation techniques that have created a whole base of cuisine which is incredibly complicated yet elegant," Williams says.

It seems that the future of food is fungus, specifically the mould *Aspergillus oryzae*, which is known as "koji" in Japan and forms the basis for much of the nation's cuisine. (When Williams was visiting once he spent time with

tenth-generation koji fermenters and people with "sheds full of squid guts".) Johnson, 28, was at the University of California, Davis, writing a PhD on flavour chemistry and gastronomy in 2011 when she heard about the work going on in the Food Lab. She remembers thinking: "A restaurant with a lab that's doing research into cuisine – that's exactly what I want to do." In June 2012, she went to work with Michael Bom Frøst – who also held a position at the food-science department at the University of Copenhagen – at the Nordic Food Lab. On her first day, she met Williams and Mark Emil Tholstrup Hermansen, who curates Noma's annual food symposium, MAD ("mad" is Danish for "food" – it's the basis

of the second half of Noma's name, a contraction of "Nordic" being the first). After returning in 2013, Johnson talked her way into a full-time job and moved to Copenhagen in July 2014 as the head of research for MAD. "I'm not sure anyone quite knows what my actual job description is," she laughs.

Soon after she arrived, the restaurant took delivery of four shipping containers. Two of these have become the latest repositories of Noma's quest for the new or, as Williams has it, "the Domesday project". The "office" for the R&D lab is a container perched on top of another with a couple of windows cut into them, an old IKEA kitchen, a second-hand bench, and various culinary and scientific devices such as a centrifuge ("it's great for things like clarifying juices, nut milks and rose oil," Johnson says). It's reached by a steep metal staircase that's as close to being a ladder as steps can be.

The containers have been divided into seven chambers that vary in temperature from -30°C to 60°C and zero to 100 per cent humidity. With close to zero budget, Williams and Johnson jerry-built a solution. "I spent a week wiring the thing," Williams says. "We finally got online on a Tuesday at two in the morning." Johnson needed to reprogram all the controllers.

The hottest chamber is what they refer to as the garum room (garum is a

Lars Williams heads up the R&D lab

"When we opened it was laughable that you could make a gastronomic restaurant with Nordic ingredients"



fermented sauce made from the blood and intestines of fish, beloved by the Romans). Here, most of the contents are protein ferments that are enzymatic, which means that they have a sweet spot of around 55°C to 60°C. “They’re very, very active,” Williams says. Vegetable-based enzymatic ferments such as black garlic are developed in an adjacent compartment. There are other rooms for growing *Aspergillus oryzae* which is calibrated to 33°C-35°C in strong humidity. The chambers are together because of thermal bleed.

In September, a time when there’s a high degree of harvesting, one of the rooms is set up as a giant dehydrator that’s maintained at around 40°C; air with zero humidity is pumped through to aid the drying process. There’s a vinegar room and another for lacto ferments where the kombuchas (fermented green-tea-based drinks) are developed. Both are in sealed containers and require a similar

temperature range, so can be stored together. When duck season opens in the autumn, game curing begins. (Storage is a big issue at Noma: Williams and Johnson recently made 100kg of soy sauce from discarded cabbage leaves, but hadn’t thought about where they might store it.)

In conversation, the pair move quickly through different food groups. Johnson talks about how they are “playing around with mackerel” and Williams adds that they “had a lot of grasshoppers around at the time”. They tried to make garum from grasshoppers and discovered that it “contains a good amount of protein”. The garum conversation continues. It’s agreed that razor clam garum has similarities to soy sauce and that squid garum is the closest there is to the Roman iteration.

“There are a lot of things that are happening in food now, especially in restaurants, that science can be

APPETITE FOR CHANGE

“What we want to do is to change the world through food,” says Mark Emil Tholstrup Hermansen, the head of development at MAD, Noma’s not-for-profit that works to expand knowledge about food. The annual MAD symposium, which started in 2011, has hosted not just presentations by some of the world’s most famous chefs but talks by chemists, farmers, entomologists, agronomists, activists and an urchin diver. Beyond this, MAD produces compendiums of writing about food, has launched a digital platform on wild food and foraging for both schools and adults, has devised a management programme for Yale and consulted for the World Bank. “The creative potential of the chef is only expressed through restaurants, but food is at the intersection of politics, nutrition, geopolitics, culture, jobs, hunger and deliciousness.”

applied to; it’s just that the work hasn’t been done yet,” Johnson says. “If you start bringing a bit of knowledge about the biochemistry of micro-organisms or the chemistry of flavour compounds and substrates, you can get a lot more precise in how you’re fine-tuning things.” Williams describes their methodology as “natural biotech”: fermentation is a kitchen tool in the way that a frying pan or an oven might be used.

“You sometimes hear about scientists working with food and it’s like, ‘Oh, you’re bringing rationality into the creative process,’” Johnson says. “No, I don’t want to bring rationality to the creative process at all, because that would ruin it. Science is not here to tell you what tastes good. Science is here so that you know how stuff works and that in turn lets you be creative with what you have.”



The centrifuge in Noma’s R&D laboratory





By the end of 2016, Noma, in its current form, will cease to exist. In January, the entire restaurant – all 80 members of staff – decamped to a warehouse in Sydney to reimagine Noma in Australia. As with a residency in Tokyo in 2015 (and, to a lesser extent, a pop-up in London hotel Claridge's in 2012), it involved not only creating entirely new menus from native produce, but moving 80 staff and their families to a new city thousands of kilometres away for a five-month period. Noma is due to reopen in Copenhagen in May 2016 but will then close at its current location – for good – at the end of December.

Redzepi and his team have found a new, bucolic site on which to launch a much larger and even more ambitious project. A five-minute bike ride north-east of Noma – skirting the hippy-anarchist commune Christiania – is an ex-military warehouse which once stored mines for the Danish Navy.

Ash-coloured clouds skim across the sky as head of development Mark

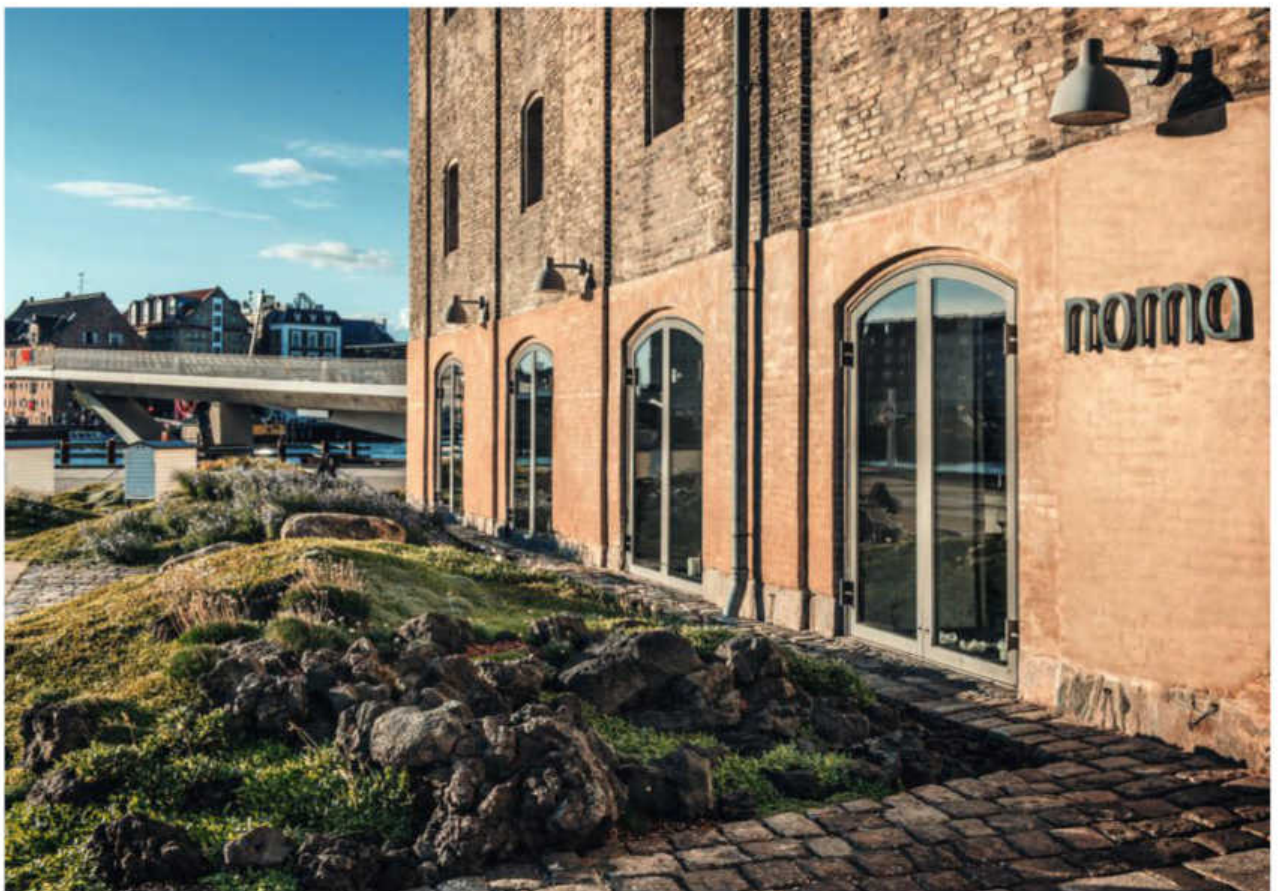
Emil Tholstrup Hermansen strides up pre-war brick steps that lead on to the roof of the building on a strip of reclaimed land between two lakes. Hermansen, an Oxford-educated, Morris Minor-driving social anthropologist, has guided the MAD symposium to becoming perhaps the most influential gathering of forward-thinkers about food. He has been part of the team that, for the past three years, has secretly worked on the project to move Noma to an entirely new site that will be designed by the Danish architect Bjarke Ingels. “We’ve been learning and researching how to cook for this region for the past few years,” Hermansen says. “Coming here allows us to make the restaurant we’ve been practising for.”

Currently the site is abandoned and has been taken over by graffiti artists – what must be thousands of empty cans of spray paint litter the floor. The one-storey property is 100 metres long – far bigger than the footprint of the current restaurant. It will have space

Mark Emil Tholstrup Hermansen, head of development, has been working to move Noma “to make the restaurant we’ve been practising for”

for offices and a gym as well as more ambitious elements of the trade, such as a smokehouse and stone ovens. But the setting – on a lakeside, surrounded by trees and nature, with a modern housing project on the other side – allows the team the opportunity to create a garden for herbs and vegetables and floating platforms on the lake for growing produce. A greenhouse will be constructed on the roof to grow ingredients that are unavailable during the winter. Currently, much of the greenery on the disused property consists of wild berry bushes, which will be left as they are. “We won’t make it too manicured,” Hermansen says.

René Redzepi prepares the chocolate-covered lichen



Noma's main entrance, with its beehives on the left



he new Noma will continue its relationships with its current producers and suppliers, but the site will offer some fresh opportunities: the restaurant will produce more compost, which will be shared with farmers, and Noma chefs will learn to work the land and to further understand the relationship between it and what ends up on the plate.

"During the winter, we can grow exactly what we need and try to be as self-sufficient as possible," Williams says, standing before the lake that future Noma diners will gaze upon from their tables. "Everything that comes on to the plate will have been made ourselves. This allows us to control every aspect of what we're doing."

Inside the warehouse a graffiti artist is working on a green outline to a large letter G. Stepping over discarded bottles and remains of campfires, Hermansen, Williams and Johnson sketch out the layout – a fermentation kitchen, test kitchen, a workshop for the fabrication of plates and cutlery, front office, an office for the MAD group,

a gym, a staff meal area, the prep kitchen, service kitchen and – the tip of the iceberg – the dining area, which will be similar to that used today.

"We've taken steps to understand what the next decade of work is," Redzepi says. "Everything we do should have long-term thinking." He is aware that Noma is a restaurant with just 12 tables, but that doesn't dull his ambition for its influence. In autumn 2015, MAD launched the National Foraging School, a programme for both adults and schools ("it will enrich [the children's] lives and it will hopefully connect them to nature in a more profound way," Redzepi says), and a Noma executive leadership programme will take place at Yale for the first time this spring. Redzepi admits that it has taken years for him to calibrate his own leadership style. "I had to physically remove myself from some situations," he says. "It was a very big decision." What he means is that he no longer oversees service as he found it difficult when things weren't done exactly the way he wanted them to be.

Spend time at Noma and what becomes clear – through the restaurant, the R&D lab, the MAD symposium and the relationships that the restaurant has built with its suppliers and broader network – is that Redzepi wants to build something more expansive than a restaurant: a global community through food.

"If you can encourage a spirit of saying that, if we can work together as a growing community, we're all part of the same organism," he says. "We're all doing our different thing but we are part of the same organism which is exploring life through food and putting all these things in the equation, like teamwork, sustainability, financial success. If we do it together we will be individually more successful in the end."

This enables the Noma team to develop an entirely new menu based on geography – wherever they are. The process begins with the team tasting as many products as possible and then creating a series of condiments based around the products that reflect the area. Only then does the process of building dishes start. Williams talks about recent trips to Japan and Zimbabwe: "You use your intuition to let the natural taste of products guide you to how you can slowly twist and shape them into something else." In Sydney, the kitchen and dining room are being built from scratch. The schedule will be intense: Williams spent Christmas

Day 2014 plucking one hundred wild ducks in preparation for the opening of the Noma pop-up in Tokyo.

The new urban-farm iteration of Noma will further develop a community around the restaurant and perhaps have a broader impact on how human beings eat beyond the higher echelons of gastronomy. Noma's suppliers must all pass a rigorous quality-control process. Williams jokingly describes the butter supplier as "an extremist". "All he cares about is making – and innovating – in butter," Williams says. Experiments have included "bog butter", which was inspired by 18th century Scots who buried the product in peat, and filtering the milk through hay so that its particular bacteria would infuse the milk with flavour.

When Noma opened it was set among derelict warehouses. Now it is surrounded by recently constructed waterfront condos. A pedestrian bridge connecting the restaurant to the central part of the city is nearly complete. Workers in hard hats and hi-vis jackets

'YOU'RE SPENDING MOST OF YOUR INCOME AS A RESTAURANT ON EXPERIMENTING – IT'S EXPENSIVE'

scurry on top of the concrete arc. Just one 20-metre expanse remains before it's complete and Noma is no longer an outpost. It's time to move on.

"You're spending most of your income as a restaurant on experimenting – that's very expensive," Redzepi says. "So you have to recognise that you do it because you love learning new things and exploring the world, meeting new people. And then you have to understand that you're asking people to go to work and feel miserable most of the time because that's what failure does to you. It's really tough. How do you create an environment that has a spirit in which that's OK? At Noma, decisions come from the gut, and what we feel is necessary. Having a good balance between work and family and expanding the community, taking lots of risks – you have to be willing to risk everything."

"You have to say, 'We take a risk now that might mean Noma is not here in two years.' Can I live with that? Yes, I can." ■

Greg Williams is deputy editor of WIRED. He wrote about Pussy Riot in 03.15



FUTURE FOOD

COMPILED BY
**GREG WILLIAMS, GIAN VOLPICELLI
& KATHRYN NAVE**

UNDERGROUND GREENS

CLAPHAM, UNCOMMON

Forget everything you were taught in biology class – plants don't actually need sunlight to grow. Growing Underground is a farm 33 metres below Clapham, south London, swapping sunlight for LEDs. "Over the past three to five years, LED development has reached the stage where we can grow without any natural light whatsoever," says Steven Dring, who founded the project (left) with fellow Bristolian Richard Ballard. "You can even change the light spectrum to cater to the different plants that you're growing."

Growing Underground's focus is on the leafier vegetables, from microherbs to baby leaf salad. They grow quickly and need little space. "What's new about the latest lights is that you can stack them very close to the crops, 25cm away, if not closer," says Dring, "so you can layer products and lights on top of products and lights." This means that spaces such as car parks, warehouses and Growing Underground's second world war tunnels are all commercially viable spaces.

Presently, Dring and Ballard are using only a 550-square-metre area fitted with hydroponics that will produce about 20,000kg of greens every year. As the business grows, so will the farm – they have a total of 20,000 square metres to expand into. And their produce will be exclusively for those within the M25. "We'll be cutting it at four in the afternoon and people will be eating it at the next lunchtime," he says. "And there's definitely a desire to do this in other cities."

Moving salad production underground frees up more space on the surface for bulkier crops or livestock. "We have a growing population and a finite amount of land," says Dring, "so we've got to find other spaces to grow in."

Sophia Epstein growing-underground.com

**FROM UGLY
FRUIT TO
VERTICAL
FARMING,
THE SEARCH
IS ON TO FIND
NEW WAYS
TO OPTIMISE,
ADAPT AND
GROW WHAT
WE EAT.
HERE ARE SOME
INNOVATORS
SERVING UP
SOMETHING
DIFFERENT**

PHOTOGRAPHY: CHRISTOFFER RUDQUIST

EDIBLE PACKAGING

The long-term goal of

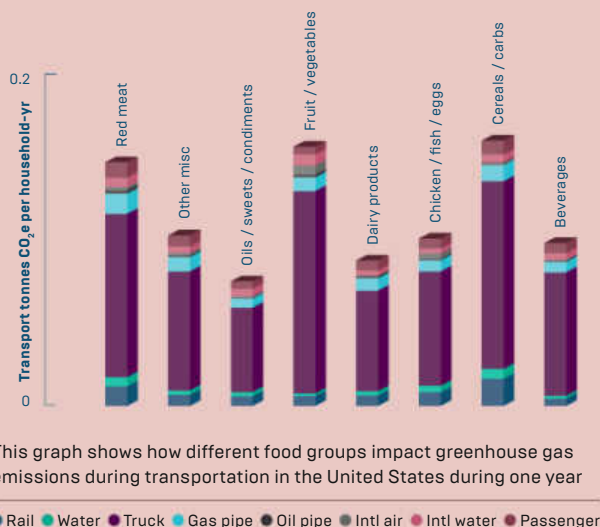
Cambridge, Massachusetts-based WikiFoods is doing away with food packaging and replacing it with vegetable-based edible wraps. It has created a product called perfectly free – soft edible casings for dairy-free ice cream or frozen yoghurt that can be washed and eaten with bare hands, no cone required. WikiFoods' mission is to alter the attitudes of retailers and the behaviour of consumers. Its partnerships with Whole Foods and New Hampshire-based dairy producer Stonyfield are a start. *quantum designs.com/wikifoods*

JUICE/YOGHURT/ICE CREAM



WIKI EDIBLE SKIN

OUTERWEAR



EAT FOR THE PLANET

The global food system accounts for around a third of all greenhouse gases. ZeroFoodprint, founded in 2014 by chefs Chris Ying and Anthony Myint, wants to help restaurants quantify their impact on the environment and work with them to reduce and offset carbon emissions. "Restaurants are primed to be leaders in curbing emissions; it's not that difficult for them to do so and they have the attention of the public," says Ying. Cutting down on meat is key, he adds: "I love meat, but eating it at every meal seems excessive. We need more creative approaches to ranching, but we can all probably eat a little less meat."

So far the non-profit is working with Noma in Copenhagen, Mission Chinese Food in San Francisco and Prime Meats in New York to provide an annual report for each.

CARBON WATCH

FOR ANT-EATERS

WHERE TO EAT ANTS

1. JIMBOCHO DEN, TOKYO

Chef: **Zaiyu Hasegawa**
The restaurant's signature salad comes with a single ant.

2. D.O.M., SÃO PAULO

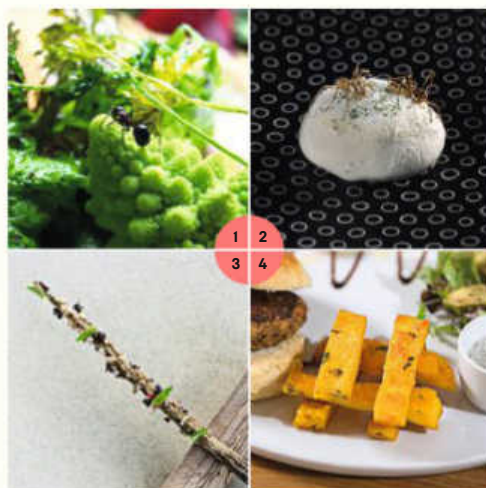
Chef: **Alex Atala**
Atala serves Amazonian ants as a garnish to many dishes.

3. NOMA, COPENHAGEN

Chef: **René Redzepi**
On the menu: liquorice root with honey and locally sourced ants.

4. GRUB KITCHEN, ST DAVID'S

Chef: **Andy Holcroft**
Grasshopper and cricket bug burger; polenta and ant fries.



URBAN FARMING

PARKWAY GARDENER

A lack of fresh local produce led Ron Finley to transform South LA's wasteland into an oasis

Ron Finley plants vegetable gardens – in abandoned plots of land along kerbs and in central reservations on freeways in South Central Los Angeles. The self-described "gangsta gardener" (right) became frustrated with his local area's lack of access to healthy food, so he took to planting fresh produce in 2010.

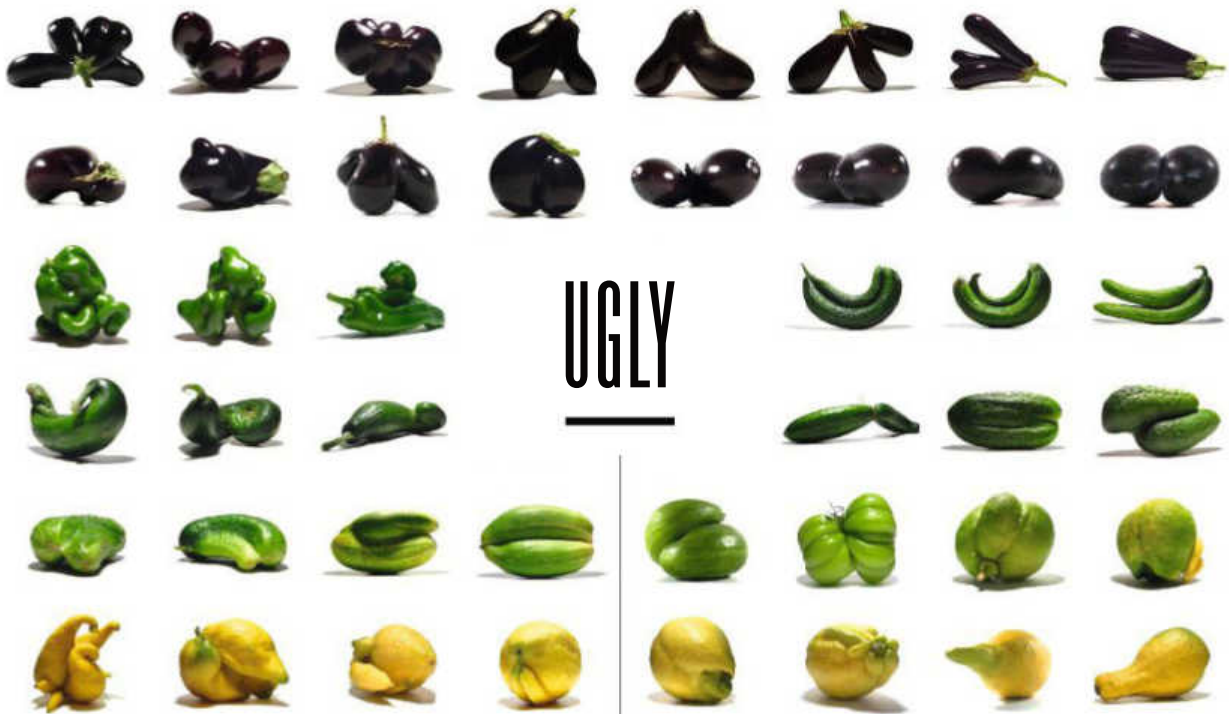
"The food supplied to these neighbourhoods was making us sick," Finley says. "It's supposed to give us health, but a lot of what we eat is totally devoid of nutrition because of the way it's grown."

Finley's activity got him in trouble with the City of Los Angeles, which owns the neglected land. He campaigned for years before the City Council performed a U-turn to allow residents to plant vegetable patches without a permit.

"I'm elated, but it's something politicians should have dealt with years ago," Finley says. "I call it bureaucratic ass-dragging."

Now, through the Ron Finley Project, he's aiming to transform South LA from "a food desert to a food forest", by running community events and workshops that empower people to grow their own hyperlocal food. "This is how we can break our chains and create a new system," Finley says.



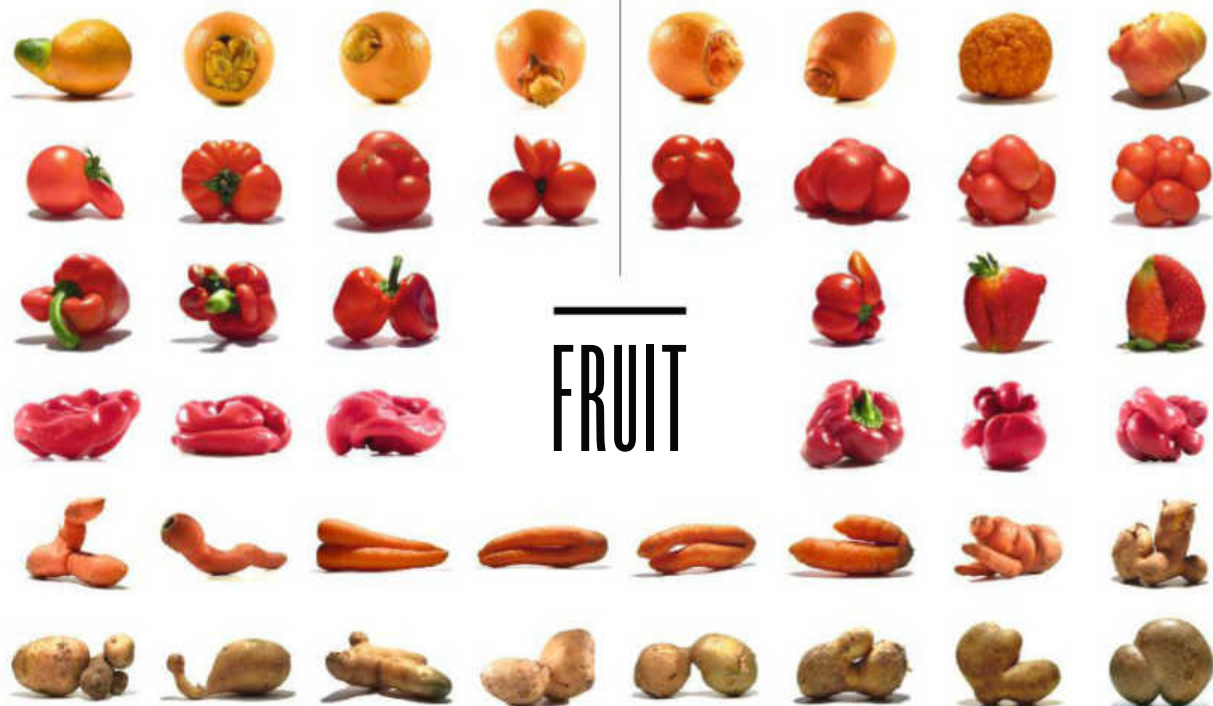


Not all fruit and veg lives up to the aesthetic standards imposed upon them by distributors, but that doesn't mean they aren't tasty. To this end, co-operatives are launching campaigns to get supermarkets to start selling misshapen items. It's a huge market - up to 40 per cent of fresh produce in the UK is rejected because it doesn't look right, according to the Soil Association, with much of it ending up as landfill.

Portugal's Fruta Feia ("ugly fruit") uses a cooperative model to deliver boxes of otherwise rejected vegetables

straight from the farmer to the consumer. "The amount of food that's produced but not eaten is shocking," says Fruta Feia's Joana Baptista. "Besides wasting the food itself, it's a waste of water, energy, soil and labour,"

The co-operative says it's already saved 180 tonnes of food from the bin, and the model has been echoed by Californian startup Imperfect Produce, which launched in summer 2015. French supermarket Intermarché and UK Asda have also promoted "wonky" fruit at discount prices.



HOW POLITICS CAN DRIVE THE CIRCULAR ECONOMY

When Ida Auken was Denmark's environment minister between 2011 and 2014, she put in place policies that aim to double the amount of recycled household waste by 2022. She didn't call the plans "waste plans" but "resource plans".

Auken espouses the doctrine of the "circular economy", and aims to cut the amount of rubbish that gets incinerated in Denmark. The country generates more rubbish per capita than almost any other EU country and around 80 per cent is destroyed. Now Danes are starting to sort their trash, and garden and food waste is collected to produce biogas and compost. If all goes well, by 2022, 820,000 fewer tonnes of waste will be incinerated every year.

However, outdated regulations still stand in the way: "If you have five lemons in the same bag and one goes bad, you aren't allowed to take it out and sell the rest," Auken says. That's where policymakers can help. "Regulations need to start focusing on resources and recycling to drive behavioural change. Setting political goals works as long as they are achievable within five to eight years and as long as politicians stick to them."



WHAT'S NEXT

SIX FOOD WRITERS

ON FUTURE TRENDS

	1. TEJAL RAO bloomberg.com	2. HELEN ROSNER eater.com	3. NICOLA TWILLEY gastropod.com
- What will we see more of in 2016?	- Sprouted lentils. They sound unsexy, but the sprouting process transforms their flavour and texture.	- Ugly produce is poised to have its moment. I'm excited to see chefs taking unwanted or imperfect products and using their skill and artistry to prove that it has value beyond the aesthetic.	- Bee larvae. It's lean protein, it can be raised to help rather than harm bee populations, and it tastes like a cross between bacon and chanterelle mushrooms.
- What will have the biggest impact on how we eat?	- More chefs are placing value on vegetable-focused cooking that requires only a small amount of meat and fish. This will change the way we farm and eat on a larger scale.	- The care going into new models of fast food – from giants like Shake Shack to upstarts like Fuku – will affect how huge numbers of people eat. It's more mindful.	- Climate change will affect yields, growing regions, and diversity in ways that we will have a hard time predicting or adapting to.
	4. CHRISTINA AGAPAKIS ginkgobioworks.com	5. BRONWEN PERCIVAL microbialfoods.org	6. MATT GOULDING roadsandkingdoms.com
- What will we see more of in 2016?	- Probiotic foods like yoghurt and sauerkraut. We're starting to see bacteria added to foods like candy bars and jelly sweets.	- Chefs are exploring whey's potential for making cocktails, vinaigrettes and as a cooking medium.	- Thoughtful eaters who eat well for the right reasons, not because it's a new form of conspicuous consumption.
- What will have the biggest impact on how we eat?	- Fermentation. Recently, microbes have been seen as more than "germs". Scientists are experimenting to create products like Afireur's cultured coffee, or engineering yeasts to explore flavour possibilities.	- Microbial terroir: harnessing the unique micro-organisms from a given environment to affect the flavours and aromas of the fermented food made there.	- Solving the water crisis. By 2050, half the world's population will be living in water-stressed areas, which bodes very poorly for the global food supply. If the forecasts are correct, droughts will be the new normal.

SOFTWARE IS EATING AGRIBUSINESS

It's arrived late, but agriculture is finally joining the networked economy. All we need now is to open-source sensor data and crop-growth strategies if we're going to feed tomorrow's urban populations, argues Caleb Harper of the MIT Media Lab

Agriculture is the backbone of human civilisation, but it's about to snap under our weight. The world is on the brink of a food crisis in which our current industrial models of agriculture will not support the projected population of nine billion by the year 2050. Our best hope for farming in the future lies with advances in technology: sensors, big data and networks. These advances will move us into an agricultural revolution that will feed more people, feed them more effectively and feed them sustainably.

In our current system of food production, an apple that you pick up at your local supermarket could be six months old and have travelled more than 18,500km to get from a New Zealand farm to your fruit bowl. Although preservation methods during this long haul keep the apple from spoiling, it is likely to lose many of its vitamins and nutrients and close to all of its antioxidants. The cost of the apple is inflated in order to pay the many links in the supply chain, and the compounded energy needed to grow, store and package it contribute to the food system's one-third share of human-caused greenhouse-gas emissions, according to reports published by the Consultative Group on International Agricultural Research.

Even worse than the standards for fresh produce are those for processed foods that are high in caloric content but so low in nutritional value that, according to the US National Center for Biotechnology Information, they simultaneously contribute to malnourishment and obesity. These foods are served up in schools and only compound the problem. The UK Health and Social Care Information Centre reports that 20 per cent of children in year six are obese.

So how can we feed the growing world population but make better, fresher, more nutritious food widely available? And sustainably? The answer lies in recognising agriculture for the science that it actually is.

For millennia, farmers have been manipulating land and plants under natural climate conditions in order to produce high volumes of desirable crops. The world relies on large, single-crop farms that are wherever the climate is best for a specific product. Often, best practices are defined by farms that produce the most saleable food at the lowest cost, with minimal concern for the environment, sustainability or nutrition.

Recently, this long-standing, industrial-era system has been questioned and challenged by technology. Many outdoor farmers have already begun to rely on drones, apps, GPS-guided equipment, big-data analyses and networks in order to improve their practices. These new technologies have allowed some smaller, local farms to re-emerge and compete with larger industrial facilities.

Sensor data is proving especially useful in modern agriculture, as it can provide highly specific information that tells a farmer exactly

what an individual crop needs at any given moment. For example, planting a ground moisture sensor for a particular plot of land can tell the farmer exactly when that plot needs to be watered. With this system, the farmer neither wastes water nor loses crops to unnoticed drought. Going further, those sensors can be hooked up to an app that alerts the farmer to what the plants need, or it may even connect directly to an irrigation system so that the process can be fully automated with the farmer needing to take no action.

This kind of technology offers farmers a degree of control, but being able to farm indoors allows us to level up our ability to manage conditions entirely. Indoor agriculture using hydroponic and aeroponic systems to grow plants under LEDs and without the use of soil isn't new, but tech is reaching a point at which it's energy efficient, cheap and sustainable. Vertical

**PEOPLE NEED TO
SHARE THE WEIGHT
THAT AGRICULTURE
HAS CARRIED**



PHOTOGRAPHY: CHRIS CRISMAN

farms are popping up in cities around the world as “locally grown” appropriately gains popularity as a buzzword in the food world.

Sensors and software are enabling significant progress in the science of agriculture. Yet the data is usually proprietary and seldom shared. Individual farms conduct research, whereas large corporations conduct big-data analyses that, although insightful, are shared only for

profit and rarely reach scientists. Farmers are often dependent on a single source of unverified data that has been provided by corporations, and local producers who cannot afford the data may be unable to compete with large networked farms.

In the realm of indoor agriculture, companies such as PlantLab have undoubtedly made improvements. Yet it's holding as proprietary secrets methods claimed to be 40 times more productive, using 90 per cent less water, for growing food that is ten times more nutritious. What we need

is an open, joined-up approach to solving a significant global problem.

The Open Agriculture Initiative (OpenAG) at the MIT Media Lab, where I work, was created to blast open the doors on agricultural research and data so that more people can learn to be farmers and help increase access to local, fresh, nutritious food. The OpenAG team builds “Food Computers” – sensor-actuated, controlled-environment systems – that generate open data in the form of “climate recipes”. It's open source – from hardware to software to data. Specific conditions inside the Food Computers can be set or adjusted manually, and can mimic natural environments, or generate ideal synthetic ones. The systems, which range in scale from personal to industrial, are intentionally hackable so that a wide variety of users can make changes and improvements that suit their specific needs.

The conditions under which plants are grown will affect the genes they express, resulting in unique phenomes – the traits that result from those expressions. By choosing specific conditions for climate recipes, growers can select for the qualities they value – flavour, colour, yield, speed of growth, etc. The data generated by Food Computers will contribute to a Wikipedia-like open phenome library, which will create a climate democracy in which climates can be uploaded, downloaded, shared, rated and improved by users around the globe.

The UN estimates that, by 2050, the number of people in cities could be 6.5 billion. With the right tech, urban agriculture could turn basements, warehouses, walls and skyscrapers into farms. Food grown hyperlocally can go from farm to table, cutting transport and storage, reducing waste and spoilage, and feeding more people with fresh, affordable, nutritious food.

Agriculture is one of the last industries to move into the networked economy. It's time to spread the data, the production and the food over a much broader field. If more people share the weight that agriculture has been carrying, we can reduce the strain on our environment, our wallets and our bodies – all at once. The age-tech revolution is on its way, and, if only for the LED lighting, the way we farm will be brighter.

Caleb Harper is director of the Open Agriculture Initiative at MIT Media Lab

Caleb Harper among his data-reared crops at the MIT Media Lab

BENIGN MASOCHISM AND THE ART OF DISGUST

CULTURAL NORMS

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The Cambodian delicacy of deep-fried tarantula is perceived to be disgusting by most westerners. Yet many Asians regard cheese as similarly repellent. Finding the limits of culinary acceptance within a particular culture can provide a rich vein for brave chefs.

"Disgust can put people off eating a food, but it can also be an attraction – what I call benign masochism," says Paul Rozin, a University of Pennsylvania psychology Professor, who has spent his career studying revulsion. "Noma served a sauce with live ants running around it. Only a few people were willing to eat it. The chef has to know that special area where you can play with disgust."

He notes that almost all foods considered disgusting are of animal origin – whether offal, arachnids, century eggs or Stilton. Overcoming disgust comes through exposure, for example by seeing friends tucking in.

YOU'LL LOVE THESE...



Fruit bat soup
Thailand



Soft-boiled fetal duck
Philippines



Casu marzu (pecorino with maggots) Sardinia



Cheez Whiz
USA



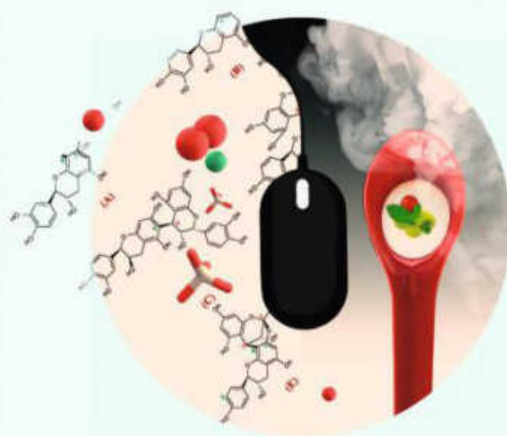
Black pudding
UK



Rodents
China



Caterpillars
South Africa



NO SHIITAKE, SHERLOCK

IBM's supercomputer Watson famously beat human contestants when it won US quiz show *Jeopardy!* in 2011. Since then, its AI has been trained to create bespoke recipes for any taste. Feed its algorithm some information about your ingredients and style of cooking, and it will crank out ideas. Here's what WIRED got when it asked for a "Chinese-style" dish with Parmesan and dark chocolate.

CHINESE PARMESAN CHEESE PANINI

- 8 slices of French bread
- 120ml grated Parmesan cheese
- 60g chopped dark chocolate
- 60g chopped unsweetened chocolate
- 120ml shredded coconut
- 60ml grape jam
- 1/4 stick unsalted butter
- 20ml tbsp packed light brown sugar

PREPARATION

Prepare barbecue (medium heat). Butter one side of each of the bread slices. Arrange half the bread slices, buttered side down, on a baking sheet; spread each with a quarter of the grape jam. Arrange a quarter of the coconut over the grape jam. Sprinkle the two chocolates evenly over each, leaving a 1.2cm border. Spread Parmesan over the plain side of the remaining slices, leaving a 1.2cm border. Place the slices, cheese side down, atop each chocolate-topped slice. Sprinkle the buttered side with a quarter of the sugar; press lightly.

COOKING

Grill each sandwich about three minutes per side. Allow to cool for five minutes. Cut each sandwich in half. ibmchefwatson.com

COGNITIVE COOKING



CECI N'EST PAS UN HAMBURGER

Impossible Foods is taking the animal out of the meat industry. In its Californian laboratory, vegetables – beans, grains and greens – are broken down into their basic components such as proteins, fats and vitamins. Then they are recombined to achieve comparable flavours and textures to flesh, down to a convincing plant-based “blood” which is derived from the molecule found in haemoglobin and which gives blood its distinctive colour.

The Redwood City startup has attracted significant investment totalling \$183 million, including a series D round of \$108 million (£120m) in October 2015 led by UBS and joined by Bill Gates and Horizons Ventures’ Li Ka-shing. According to some reports, Google made a rejected bid to acquire Impossible Foods last year, valuing the company at \$200 million to \$300 million.

The startup has set “hardcore beef lovers” as its target market and says it will launch its first meat-free “impossible hamburger” in 2016. It claims that the product will have the benefits of a plant-based foodstuff – no cholesterol, antibiotics or hormones – but will possess the umami-rich taste of meat because of the proteins and nutrients that it has identified. Founder Patrick Brown says his company is taking food “from the landline to the iPhone” era. WIRED’s editor tasted a prototype last November. His verdict? “Wow, that tastes like a burger.” impossiblefoods.com



FARMING

THE BIGGEST VERTICAL FARM IN THE WORLD

AeroFarms' headquarters in Newark, New Jersey, is a former steel factory that's been converted into the world's largest vertical farm. Throughout the 6,410m² of growing space, plant beds are stacked on top of each other in 12 layers between floor and ceiling. LEDs provide lighting and the roots of leafy greens, herbs and salads are kept nourished using an "aeroponic" mist claimed to use 95 per cent less water than outdoor agriculture.

"This is game-changing in terms of productivity," explains Marc Oshima, AeroFarms' co-founder. "We can take the same seed that might take 30-35 days to grow outside, and it will have a 12-16 day crop cycle in our system, so we can have 20 crop cycles a year."

AeroFarms' agricultural optimisation relies on algorithms that continually monitor nutrients and lighting at different points in the plants' growth cycles. By optimising light wavelengths and the nutrient-filled mist, operators can endow plants with different tastes, textures, colours and yield. "For example, we can make watercress spicier and lettuce sweeter," he says.

The flagship facility, in partnership with RBH, Prudential and Goldman Sachs, will be able to produce 900,000kg of vegetables – which will be distributed to local buyers – annually when it reaches full capacity, predicted for midway through 2016.

FISH FOOD

INSECTS INSIDE

Can insects make fish happier? Ynsect thinks so. The French company believes that the current practice of feeding seafood-based meal to farmed fish is critically depleting the world's marine life and disrupting the food chain by removing smaller fish that are the basis for the feed. Instead, Ynsect is farming beetles and flies fed with bioconverted organic substrates, such as cereal by-products, and then transforming them into fish food. Other by-product substances that make up the insect bodies – such as chitin – are then channelled into the cosmetic industry; insect manure can be recycled as fertiliser. ynsect.com



Ynsects' beetles are fed with organic matter, such as food waste.



The larvae they produce are fed until they're grown enough to harvest.



The insect parts (protein, lipid and chitin) are extracted and purified.



Proteins and lipids go to the nutrition market, chitin to cosmetics.

FOOD WASTE? NOT SO LONG AS MICROBES ARE HUNGRY

RECYCLING

This composting machine reduces the volume of food waste by 90 per cent in 24 hours. The self-contained aerobic food-waste composter uses a microbe that thrives in high heat and saline conditions. Large pedals churn the material to introduce air, and a heat jacket keeps the temperature up.

"The key is the microbial culture so that you never fully empty the machine. It's akin to making sourdough," explains Peter Goodwin, director of Closed Loop in the UK.

But the loop doesn't close until the compost is put to good use. The City Harvest programme in Melbourne starts with Closed Loop installing composting units in restaurants. The compost is then given to local growers who in turn sell their produce back to the restaurants.

The machines themselves are evolving, with touchscreen, heat controls, sensors and diagnostic tools.



BIOTECH

THE NON-BROWNING APPLE

Apple aesthetes, rejoice! Canadian biotechnology company Okanagan Specialty Fruits has edited a potato gene into apple trees, creating fruit that never browns. Its first product is the Arctic apple (*below right*). It hopes to extend its technology to other fruit such as peaches, cherries and pears. okspecialtyfruits.com

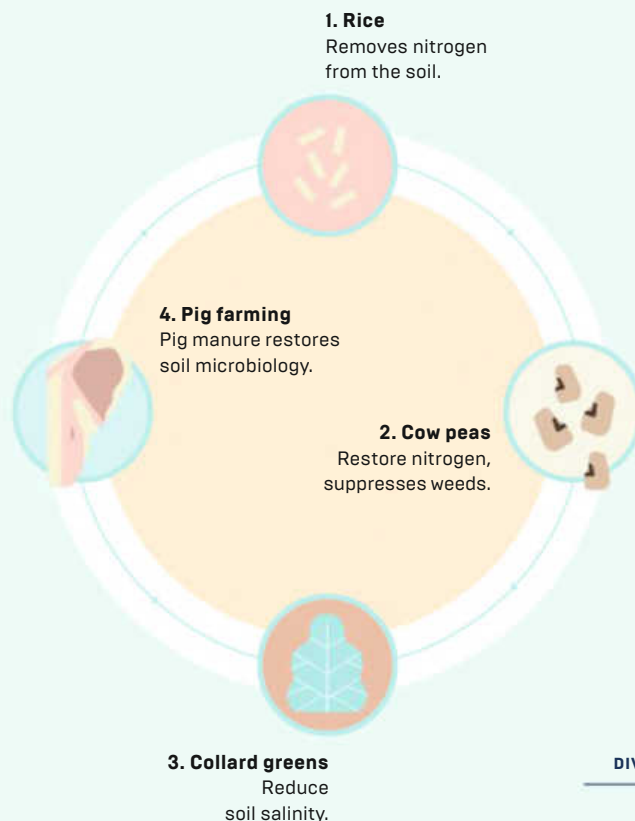


After four hours' exposure to the air, the Granny Smith (*left*) has browned more than the Arctic apple

ON WHOLE-FARM EATING

Western countries are set up to grow a handful of crops in giant monocultures. Dan Barber is a champion of crop diversity – using traditional rotation methods to restore nutrients to the soil. The New York-based chef argues that the tastiest cuisines in the world have emerged in this way; Japan's is based on rice, but to improve soil health you need seasons of buckwheat and soy beans. There is a market for all three, so farmers are incentivised to grow them. "In the US, we

never had that," he says. "This means there's no market for rotational crops such as clover, rye, barley or kidney beans. So monoculture prevails." That's where chefs can play a role. "Restaurant menus can become a template for a cultural shift towards eating responsibly and with a diversity that corresponds to the landscape," Barber says. Here, a rice and pea dish, called Hoppin' John, illustrates how Barber's crop rotation might be practised:



DIVERSITY



ROBOCROPS

Japanese agritech company Spread believes that farms should have no farmers.

The indoor lettuce farm that Spread will open in Kyoto in 2017 will be entirely run by robots and automated conveyor belts. The company forecasts that the site will produce about ten million lettuce heads a year, while also being greatly more efficient: it could manage to recycle up to 98 per cent of the water that it uses to grow the plants. It will also, obviously, cut labour costs. spread.co.jp

ROBOTICS

FISHING

Japanese fishermen know how to keep fish fresh and delicious between catch and cooking. They have honed a killing method known as *ike jime*, which means "close the fish alive". The 350-year-old technique extends the process of rigor mortis, during which an umami compound called ionising acid is released. The slower the rigor mortis, the more umami – and therefore, flavour – is released.

HOW JAPANESE ANGLERS KEEP FISH FRESH AND TASTY



1.
As soon as you catch the fish, calmly handle it and kill it immediately with an ice pick between and above the eyes.



2.
Put a blade between the third and fourth gill on one side and cut towards the mouth to sever the major blood vessel. Drain.



3.
Cut the spinal cord at the tail. Insert a thin wire and run it up the spine. The fish will spasm, keep moving the wire until it is still.



4.
Leave the fish, head down, in a bucket of seawater for 15 minutes and then place in a cool box with ice.



DESK SNACKING

MEALWORMS ON THE MENU

According to research

from Bard College in New York state, beef is among the most environmentally troubling products to farm: it requires 160 times more land per calorie than staples such as wheat, rice and potatoes, and creates 11 times more greenhouse gases.

Inspired by a study of industrial meat production, Katharina Unger has found an answer: mealworms, which contain a similar amount of protein content to red meat. The Austrian industrial designer has developed a desktop hive, the, LIVIN Farm Hive, that lets you harvest protein grown on your desk.

The device, which is 61cm tall and resembles a chest of drawers, is designed to sit on a kitchen worktop and produce 200g to 500g of mealworms per week. Mealworm pupae are put into the top and develop into beetles in a drawer below. These breed and lay eggs that fall into the next drawer down the stack. Once they hatch, the worms drop down as they mature, ending up the bottom of the hive, ready to be frozen and then prepared. The hives beat their Kickstarter goal in January, and are scheduled to go on sale in spring 2016 for \$699.

livinstudio.com

By
Olivia Solon

The egg industry hates this omelette.

Photography:
Gregg Segal

That's because it doesn't contain eggs. The company behind it, Hampton Creek, is taking on Big Food with novel plant-based ingredients it says are healthier. And that's making it some enemies

Just Scramble
is Hampton
Creek's egg
substitute
made from plant
protein – a key
ingredient of
this omelette

*Illustration:
Jean Jullien*





HAMPTON CREEK'S HEADQUARTERS IS

in an unassuming green-grey building in an up-and-coming part of San Francisco. There's nothing to suggest it's home to one of Silicon Valley's hottest startups.

Yet inside it's buzzing with staff crammed MacBook-to-MacBook around a large table and on sofas. There are rows of kitchen equipment, with chefs mixing, tasting and baking. The smell of fresh cookies hangs in the air.

Hampton Creek, a food company powered by technology, makes egg-free mayonnaise substitute, oil-free dressings and plant-based cake mixes. It's not the first to do so, but Hampton Creek isn't just another vegan startup. Its founder, Josh Tetrick, has a more lofty ambition: to use food as a platform for change, swapping resource-intensive animal ingredients for plant-based ones to create delicious products that are accessible to the masses.

"The food system today is degrading to our planet and to our bodies. How can we change that?" 35-year-old Tetrick asks in a soft Alabama lilt. "I am using food as a means to solve problems that have an impact." It's a mantra that WIRED hears repeatedly, uttered with the evangelical fervour of a preacher. "Everything I do, everything I say, every person I hire, every customer we acquire, every policy we try to change is animated by that," he says.

WITH THE EXCEPTION PERHAPS OF California-based Soylent – which makes a meal-replacement shake for culinary killjoys – it's hard to think of another food startup that has attracted as much attention as Hampton Creek. In its four years of operation, the company has raised more than \$120 million (£80m) in funding from investors such as Asian billionaire Li Ka-shing, Yahoo! co-founder Jerry Yang and Facebook co-founder Eduardo Saverin. It has also secured distribution deals with retail giants including Walmart, Whole Foods and Target, as well as the world's largest contract food service company, Compass Group.

Sales of Hampton Creek's products have grown by 250 per cent in the past year, with its valuation among investors growing from \$3 million to \$1 billion over the past four years. At the same time, the company's journey has been punctuated by controversy, ranging from a lawsuit with Unilever over the description of its egg-free Just Mayo product, a smear campaign from the American Egg Board and a couple of high-profile articles questioning the science and ethics of the startup based partly on interviews with former employees.

"It's incredible they've been able to scale so quickly – particularly when dealing with a lot of logistics and

JUST COOKIE DOUGH AND JUST COOKIES

Hampton Creek has a variety of cookie flavours including peanut butter, oatmeal and raisin, and chocolate chip. In each case the butter and eggs have been swapped for canola and palm oil, and sorghum flour. The cookies are distributed through food service company Compass Group to schools and other institutions across the US.

transportation. Most companies are only dealing with scaling software and building servers," says Mustafa Suleyman, co-founder of London-based AI startup DeepMind and an investor in Hampton Creek. "This is bigger than eggs. It's a whole new approach to food science that has enormous potential."

The first time WIRED meets Tetrick, he bounds over with enthusiasm and delivers a firm handshake and a big

smile. Wearing the startup founders' uniform of a T-shirt and jeans, he speaks purposefully and repetitively, falling back on well-trodden mission statements at every opportunity. At times he lowers his voice to share an off-the-record anecdote.

Tetrick grew up in Birmingham, Alabama, in a small apartment with his mother and brother Jordan, who also works at Hampton Creek. Most of his youth was spent focused on trying to become a professional American football player. "That was my identity, my fixation, my entire sense of self," he says. Although bright, he made no effort with academic work; his high-school friends would, he says, describe him as a "dumb jock".

After winning a football scholarship to West Virginia University, Tetrick realised he wasn't good enough to play professionally, so he started to knuckle down and focus on academia, transferring to Cornell University in New York. After graduation in 2004, he won a Fulbright scholarship that allowed him to travel to Nigeria and South Africa – the first time he'd left the US – to teach street children.

He returned to enroll at the University of Michigan Law School. It was around this time that he started experiencing abnormal heart rhythms and was sent to a cardiologist, who diagnosed him with hypertrophic cardiomyopathy, a potentially life-threatening disease that thickens the heart muscle. The diagnosis meant that the sports-mad student could no longer lift weights or play basketball or football – even recreationally.

"If I think of moments in my life that were utterly devastating, that was one of them," he says.

It's this condition that explains the daily alarm that pops up on his iPhone every day at 7am: "Prepare to die." It's a morbid reminder to make the most of the time he has in this world.

The diagnosis motivated him to channel his energies into pursuing a more meaningful lifestyle. He headed to Liberia after graduation to help reform investment laws while working on social campaigns to help children – particularly girls – get back into school.

"I liked telling people about it. I was creating a new identity," he says. He enjoyed the reactions he got from people who thought he was a "good dude", but he started to question how much impact he was really having. This realisation made him return to the US and study complex systems involved in food, energy and education. "The more I drilled into food, the



The food system is degrading to our planet and bodies. How can we change that?

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more I thought capitalism could be used to reorient the system," he says.

That reorientation began with chicken eggs. "We had to start somewhere," he says. He adds that 1.8 trillion eggs are laid each year, the majority of which come from battery farms, where birds are packed into tiny cages. Beyond animal-rights issues, egg farming is also inefficient, requiring 39 calories of energy to produce one calorie of protein – compared with the 2.2 calories of energy required to make one calorie of plant protein.

Another reason for focusing on eggs is that they are a "hidden" ingredient throughout the food system: you can find them in cakes, scones, pastries, custards and pies. "Would anyone really care if they had a muffin without a battery-caged egg in it?" Tetrick asks.

Josh Tetrick
tucks into
pancakes made
using plant-
based egg-
substitute
Just Scramble

HAMPTON CREEK WAS FOUNDED IN December 2011 with an initial business plan to sell plant-based ingredients to food giants. However, Tetrick realised that to make change happen quickly, he had to sell products directly to consumers. The first product, Just Mayo, swapped eggs, which account for ten per cent of traditional mayonnaise, for Canadian yellow peas.

Hampton Creek soon found other plant proteins to develop a line of dressings and bake mixes. Its Just Cookies dough uses sorghum instead of dairy products. The same core ingredients can be used for waffles, cakes and muffins.

Much of 2015 was spent developing Just Scramble, a liquid egg substitute – based on a bean (kept secret for now) – that can be fried like a regular egg.

WIRED tried a version in August 2015, and found it to be persuasively omelette-like, recognisable as cooked egg, but slightly more chewy and less flavoursome. The formula was still being tweaked in November, with a launch date pegged for the first half of 2016. So far, there have been no Hampton Creek product launches that are dramatically different from those already created by explicitly vegan brands. California's Follow Your Heart, for example, creates a vegan mayonnaise called Vegenaise as well as dressings, dips and an egg replacement called VeganEgg. What separates Hampton Creek is the leaping ambition and an ability to make vegan products appealing and accessible to the masses – partly by avoiding talking about the fact that they are vegan.



PEOPLE DON'T BUY OUR PRODUCTS

because they care about animals. They buy them because they taste good and they are affordable," Tetrick says.

The current marketplace for plant-based products is dominated by what Tetrick describes as alternative brands aimed at a niche audience. Hampton Creek, on the other hand, is aimed at the mass market: the average parent who is "too damn busy" and doesn't have the time or money to feed their family better.

By chasing the mainstream market, Hampton Creek believes it is better placed to drive a systemic change in the food system. This explains why Tetrick is so proud that his products are stocked at the Dollar Tree discount store. "How many other brands that are better

JUST SCRAMBLE

It's been long promised by Hampton Creek, but the liquid egg substitute Just Scramble won't be ready until the first half of 2016. It's based on a bean that Hampton Creek discovered using its plant protein database, but so far the team hasn't nailed a formulation that freezes well.

for the environment are at a price point that works for Dollar Tree?"

Another major milestone in the company's expansion was securing a deal with Compass Group to distribute its egg-free cookies, mayo and dressings to 2,300 public schools, healthcare organisations and other institutional food providers.

"The biggest food service company in the world would never eliminate their incumbent mayo [Hellman's] for Veganaise," Tetrick says. Time and time again he relates Hampton Creek's mission to Apple's - not aiming to be the first to market but the best. "Was there an MP3 player before the iPod? Yeah. Did it take off? No. Probably because the iPod was better."

It's fighting talk like this that has helped embroil the company in a series of disputes with Big Food.

WIRED's second visit to Hampton Creek's headquarters comes four days after the CEO of the American Egg Board (AEB) resigned in the wake of revelations that the government-backed group conducted a smear campaign against the food startup. Joanne Ivy took early retirement after emails published under the US Freedom of Information Act revealed how the egg lobby had used shady tactics to tackle Hampton Creek, which it described as a "major threat" to the \$5.5 billion US egg industry.

The emails show that the AEB attempted to prevent the sale of Just Mayo at Whole Foods, advised Unilever on its lawsuit and assessed Hampton Creek's patents for flaws. In one email thread, an executive even joked about killing Tetrick: "Can we pool our money and put a hit on him?" asked Mike Sencer, executive vice president from AEB member company Hidden Villa Ranch. AEB executive vice president Mitch Kanter replied, offering to "contact some of my old buddies in Brooklyn to pay Mr Tetrick a visit".

The revelations prompted an investigation by the US Department of Agriculture (USDA) into the board.

WIRED asks Tetrick for his reaction to Ivy stepping down. His eyes light up and he grins. "It's not the first time an organisation has come after us," he says, mentioning a lawsuit filed by Unilever in 2014 that was withdrawn after 34 days. "It's an admission of something being a little screwy here."

Unilever's quibble was over Hampton Creek's use of the word "mayo" to describe its product. According to the US Food and Drug Administration's (FDA) standards of identity, a foodstuff can't be classified as "mayonnaise"



Testing lab Hampton Creek's research and development team tests its sweet products

without eggs. The year after Unilever dropped the case, the FDA issued Hampton Creek with a warning over its use of “mayo”. Tetrick’s defence is semantic: he argues that Hampton Creek purposefully chose to name the product “mayo” rather than “mayonnaise” to make sure it didn’t have to conform to the FDA’s standards of identity. In December 2015, Hampton Creek said the FDA had agreed to the Just Mayo name remaining, in exchange for some label clarifications.

Although the AEB may have overstepped the mark, some observers argue that the Big Food versus startup conspiracy is being overplayed in a way that fits in with the David and Goliath narrative Hampton Creek is spinning.

“A lot of it is a storm in a teacup,” says John Ruff, president of the Institute of Food Technologists and former senior vice president at Kraft Foods. “The idea that Big Food is bullying poor little Hampton Creek I take with pinch of salt. Hampton Creek has been very negative about Big Food so it is hardly surprising there has been some pushback.”

Ruff believes that the egg board probably went too far, but doesn’t think there’s anything particularly sinister about the FDA going after Hampton Creek for its product name (“Like it or not, food companies have to follow the rules”), nor Unilever attempting to sue.

“Food companies file lawsuits the whole time. It’s not personal. I would be surprised if more than one or two people at Unilever even care about it.”

Ruff believes that Hampton Creek is “fuelling the fire” to create hype around its products. If it is, it’s working. Bart Swanson from Horizons Ventures, which has invested in Hampton Creek, describes the Unilever lawsuit as “a godsend”. “It gave us a lot of free publicity, which helped sales,” he says.

LEE CHAE IS HAMPTON CREEK’S

head of research and development, leading a team of 17 people with backgrounds in food science, biochemistry, data analytics, material science and molecular biology. The team focuses on finding plant proteins that could be used to replace animal proteins in common foods. They do this using a proprietary platform that scans databases of plants to isolate attributes that are desirable in food, whether that’s texture, flavour or mouthfeel.

The team will take a piece of plant material, grind it up, split it into



Lee Chae leads the team searching for the latest plant proteins to replace animal products

samples and then carry out a series of tests to extract and analyse different subsets of molecules. Chae, who has a PhD in plant molecular biology and studied at the University of California, Berkeley and Stanford, says the team has tested around 100 plant samples to date. Each piece of plant material generates hundreds, if not thousands, of data points. All the results are stored, along with hundreds of thousands of publicly available data points relating to molecules that have already been sequenced, botanical information and the evolutionary relationships of plant species.

“We are creating a predictive model that lets us target particular proteins with the functionalities we desire so that we only need to test 700 samples instead of 7,000.”

This technique has helped identify a “roster” of candidate plant materials that they wouldn’t otherwise be using,

including the bean that forms the basis of the Just Scramble product. The candidate plant materials are passed on to a team of five chefs – which includes former *Top Chef* contestant Chris Jones – to play around with.

“We hand them the information and they try to come up with a formula that tastes great,” Chae says.

Nailing the formula can take months. “It can take 2,000 tries or it may take 50 to nail, but as a company we will not release it until it’s perfect,” Jones says.

Progress at Hampton Creek has at times been slow and frustrating. “Not every experiment we do or machine we have is going to work,” Chae says.

In one instance, the team was isolating proteins from a bean source and a cereal source and combining them to make a dip; the proteins became gritty when mixed. Another time, the team was trying to make a soft spread based on pea sources, but the prototypes came out with a hard texture. “We were never able to make them spreadable, but they did bounce well,” Chae says. “The science we’re doing is a combination. It’s a new focus and there aren’t any models out there we can copy. We’re figuring it out on the fly. Sometimes we try 17 things that don’t work; it sucks sometimes.”

Because of this, he understands why some of the early scientific team – since departed – have been quoted in magazine articles criticising the company. In a *Business Insider* piece in August 2015, former Hampton Creek staffers said it overplays the scientific innovation taking place and described it as a “food company masquerading as a tech company”.

JUST MAYO

Hampton Creek’s flagship product launched in September 2013. The mayonnaise substitute swaps eggs for the Canadian yellow pea. Just Mayo comes in a range of flavours including chipotle, garlic and sriracha (a spicy sauce made with hot chilli and garlic). It’s available in mass-market retailers including Walmart, Target and Dollar Tree.



BIG FOOD VERSUS HAMPTON CREEK

In September 2015, a US Freedom of Information request revealed emails showing how the American Egg Board was planning to undermine Hampton Creek.

From: Joanne Ivy [then CEO of the American Egg Board, since retired]
Sent: August 20, 2013
To: Maher, Missy [then a PR at Edelman]; Jensen, Elizabeth; Schaffner, Serena
Subject: RE: Beyond Eggs

Missy, I am getting a lot of emails about this product from egg producers and further processors. The further processor considers this a serious threat to their business. We think it would be a good idea if Edelman looked at this product as a crisis and major threat to the future of the egg product business... I was wondering if we should hold a conference call this week to discuss or if Edelman would like to present your recommendations and move forward. I am feeling this is turning into a crisis!

From: Joanne Ivy
Sent: December 03, 2013
To: Chad Gregory [CEO, United Egg Producers]
Subject: Beyond Eggs

Chad, the article on Beyond Eggs [Hampton Creek's former name] in your November 22 United Voices reminded me of a comment made by Anthony [Zotezzi, an entrepreneur]... Although it was first publicized that Whole Foods had the Beyond Eggs Just Mayo on their shelves. They are now saying it will be fall. According to Anthony, it would only take a single call to Whole Foods to have them not take the mayo. Anthony said he would make that call. However, I feel sure he wants to be paid for doing it. I will contact Anthony and remind him to make the call unless his price is too steep.

From: Joanne Ivy
Sent: , November 20, 2014
To: Howard Maguire [government relations specialist]
Subject: Beyond Eggs

Howard: I just got off the phone with a guy working with the Unilever case with Hampton Creek. He wanted to say that we supported Unilever in this lawsuit against Hampton Creek, but I told him that we could not take a position. However, since the regulation requires egg in mayo and their product does not, I said that they should make sure that the FDA is aware to address this situation. I feel sure they are aware, but maybe they need to be pushed. He also asked for a spokesperson and I said that we are not able to provide a spokesperson, but he may want to contact his egg supplier, because possibly someone with that company would be willing to talk about the benefits of real egg in mayo and false advertising with a non-egg product. Just a thought.

From: Mike Sencer [of AEB member Hidden Villa Ranch]
Sent: October 31, 2014
To: Debbie Murdock [of California Grain & Feed Association]
Cc: Arnold Riebli; Steve Gemperle; Gary West; gforster; Joanne Ivy; Chad Gregory
Subject: Disruptors in 2014: Hampton Creek Foods – Comments on Chickens and Eggs

Can we pool our money and put a hit on him?

From: Mitch Kanter [of the Egg Nutrition Center]
Sent: December 03, 2013
To: Kevin Burkum [AEB]
Subject: More Beyond Eggs Love

In the meantime, you want me to contact some of my old buddies in Brooklyn to pay Mr Tetrick a visit?

In addition to the criticism that Hampton Creek overplayed its science, ex-staffers also claimed the company exaggerated a database of plant samples it analyses and mislabelled ingredients.

They also alleged that the original formula for Just Mayo wasn't developed in-house, but instead by food-technology company Mattson (Tetrick admits the first formula was developed by Mattson, but it has since been reinvented in house) and that the company guaranteed a six-month shelf life for the product without sufficient testing to make the claim, something Tetrick denies.

In isolation, none of the claims are particularly damaging. Startups are prone to exaggeration and ex-employees often trash talk. The stories provided gossip fodder within Silicon Valley and Tetrick, who has addressed most of the claims publicly already, is clearly tired of talking about it.

Chae acknowledges some teething problems. "We hired certain skillsets prematurely," he says. "Some of the positions may have seemed more plug and play when actually we still had to build a lot of the processes. I feel bad because some people were hired before we were quite ready."

A major coup for the company was the August 2015 hiring of Jim Flatt, the former chief technology officer at Synthetic Genomics, who has a solid track record of using synthetic biology to develop sustainable fuels and chemicals for agriculture. Tetrick views Flatt's arrival as a validation of the work Hampton Creek is doing.

"Lee and Jim wouldn't work here if we weren't doing science," he says.

Flatt, who has taken up the role of chief of R&D, describes the environment as "contagious" and, having scrutinised the company's research capabilities, says the science is sound.

"Many of the underlying tools, such as instrumentation to perform high-throughput screening of compounds, large data set analysis and model-building algorithms, have been developed and demonstrated in other applications such as drug discovery or cell systems for renewable production

of commodity products," he explains.

It's unusual for food companies to talk enthusiastically about their technology – most try to conceal how the proverbial sausage is made with a façade of earthy wholesomeness, focusing on fields and sunshine rather than test tubes and protein isolation. However, Tetrick has had to speak to Silicon Valley as Hampton Creek looks to attract investment from venture capitalists and lure talent away from other startups. This requires putting extra emphasis on Hampton Creek's technological capabilities – something the likes of Unilever and Kraft don't need to do.

"Food is an emotional topic. We have to find the right balance between art and science," Tetrick says. "Nobody wants to think a computational biologist contributed to their pancake."

Ultimately, it doesn't matter how many items there are in the company's database, what equipment it has in the lab or how groundbreaking the science is. It only matters that the company can produce a high-quality, low-cost sustainable product that major retailers stock and people will buy.



HEN TETRICK FINDS OUT THAT WIRED has been asking investors questions regarding Hampton Creek's bad press, he is quick to intervene, threatening to stop co-operating on what he assumes will be another "negative" article.

Tetrick starts screening WIRED's emails to his colleagues. He takes time out from a conference he's attending to complain about an email sent to his head of communications – intended for Jim Flatt – just five minutes earlier.

But, for all Tetrick's nervousness about WIRED's line of questioning, his investors are unfazed. "To disrupt an

DRESSINGS

In November 2015, Hampton Creek unveiled a range of dressings including Just Ranch and Just Italian. These are distributed to thousands of organisations through the deal with Compass Group.



industry you have to upset the apple cart,” says Bart Swanson, a UK-based Hampton Creek board director.

Mustafa Suleyman adds: “To scale quickly you need to have a high error rate. Successful companies need to take risks, make judgement calls and, when they are wrong, correct it and move on.”

Tetrick wouldn’t discuss some of the high-profile departures, such as Google Maps developer Dan Zigmond and Hampton Creek CSO and investor Ali Partovi. Zigmond was hired in 2014 as vice president of data, but left in early 2015 and is now listed as an adviser. Partovi joined the company in September 2014, but left after nine days.

“The people that work for this company come in early and work hard. We can’t build what we want to without grinding. This is not sexy,” he says, gesturing at the chaos of kitchen equipment strewn around him.

He adds that he’s come to realise that the people who sound good on paper aren’t necessarily the ones prepared to grind the work out. Creating the right culture has involved a steep learning curve. The hiring of Allison Hopkins was, he says, a turning point.

Hopkins is a human resources veteran who helped to scale Netflix from a company of 250 employees to one of 4,000. She was coaxed out of retirement to join Hampton Creek as VP of people in October 2014.

“I’ve worked with very disruptive 133 companies, but this one took the cake,” she says. Everyone eats, and I thought what the company was doing was a much bigger legacy play than an app or some other hi-tech gizmo.”

Within months, she had laid off 17 staff, about a fifth of the team – which she describes as a “healthy move”.

“They were all smart, well-intentioned people and were right for the company at the start, but companies go through phases,” she explains.

Hopkins has helped to double the size of the company to around 90 employees. She says she looks for people with the right mindset over and above the right skills.

“Have they stepped out of their comfort zone or pivoted? We want fight, not flight or freeze.” If people don’t fit the culture they need to be dealt with quickly. “You can teach skills but you can’t teach culture,” she adds.

Chris Jones
cooks up omelettes to figure out how to get the texture and taste of Just Scramble more palatable

THREE MONTHS AFTER THE FIRST visit to Hampton Creek in August 2015, WIRED is invited to the new HQ – a huge warehouse with a ten-year lease indicative of the startup’s long-term vision.

When WIRED sits down with Tetrick, he explains why he reacted so defensively over previous questioning. He doesn’t want to get involved in Silicon Valley gossip. It all comes back to the mission: “All I want to do is maximise the impact and do something positive.”

Despite being based in San Francisco, Tetrick doesn’t see Hampton Creek as a Silicon Valley company. In fact, he’s scathing about the amount of energy in the Bay Area being used to build companies that solve trivial problems.

The next major product launch will be Just Scramble. The team needs to work out how to get the egg patties to not “taste like mush” after they’ve been frozen, but he’s confident it will be on sale in the first half of 2016.

After cracking the egg, Hampton Creek is turning its attention to the chicken: a plant-based nugget substitute is now in development.

“We just did a big taste test,” explains Tetrick, who briefly gave up his veganism to try a range including the McDonald’s Chicken McNugget.

In the next year the company will announce a number of major partnerships outside of the US, including a five-year global deal with Compass Group and one with a major UK retailer. Tetrick maintains he wouldn’t be content if Hampton Creek was bought out after two years for several billion dollars. “I want to create more of a positive change in the world,” he says.

That wish extends to his fortune. WIRED learned that Tetrick had set aside his equity in the company to put towards girls’ education in Africa and other causes. He says “bragging” about philanthropy makes him feel “queasy”. “I want to have kids one day, but beyond that I don’t crave for a lot else. I feel motivated knowing that whatever financial outcome I have can be used to make an impact.”

Success, he says, isn’t about being acquired and cashing out. “It is measurable as water saved, carbon emissions taken out and the lives of girls in Liberia changed. That’s what gets me up in the morning.”

Olivia Solon is a former WIRED journalist



By
GREG WILLIAMS

Online vigilante James McGibney says he's protecting the web from bullies and paedophiles. He packs a gun for his own protection and faces down his enemies. But the world of bully-baiting has its own murky ethics

THE

Photography:

**ANDREW
HETHERINGTON**





JAMES MCGIBNEY HAD BEEN MULLING OVER THE IDEA OF A DATABASE OF INFIDELITY FOR SOME TIME BEFORE HE GOT ROUND TO LAUNCHING IT – WITH A CHARACTERISTIC EYE FOR PROMOTION – ON VALENTINE’S DAY IN 2011.

HE HAD BEEN CONSIDERING such a website since serving in the Marine Corps: a friend had returned from a posting in Japan to discover that, not only had his partner been cheating on him, but there was another compelling detail – she was pregnant with somebody else’s child.

“You have Match, you have eHarmony... And you don’t know who you’re meeting when you’re on the dating scene,” McGibney says of his thinking at the time. “Where is the site that could expose that? Or where’s the ‘cheater check’ to make sure that this person isn’t married with three kids? That’s a big problem within online dating.”

The website, which McGibney called CheaterVille, hosted grievances – in some cases backed up by phone logs, texts or evidence taken from online media – regarding the fidelity of named individuals. Visitors to the site were able to vote on a “cheater meter” whether they thought the subject was guilty or not. On one page, from

March 2011, the top image on the site was a dark-haired woman – she was named and the city where she lives was identified. The person who had uploaded the information described her as a “junkie sc*m cheater” (CheaterVille always took a dim view of profanity as well as duplicity). The man below her, from Oregon, was described as a “DIRTY, ab*sive liar”. The woman below this had a stamp saying “proof” on her profile. The next woman down, from Boston, was described as a “Crazy Ex Stalker”.

The site was a demoralising litany of human weakness and retribution – yet, with no marketing at all, there were 500 posts on the first day, largely driven by people sharing the link on social channels. According to McGibney, 81 per cent of the people who posted on CheaterVille were women and “out of that, about 50 per cent were women who were outing other women”. Its creator had built perhaps the world’s largest database of betrayal, a search engine on which users hoped never to find their own name; the Wikipedia of treachery.

“Within the first 48 hours we had 250,000 unique hits,” McGibney says.

But, of course, data is only as reliable as its sources: inevitably, it contains biases, both social and cultural. Offer the world a platform for mischief and impropriety, and there are enough people who will grasp the opportunity to exercise their partiality for censure and reproach. In the case of CheaterVille, this meant some posts were malicious, incorrect or both. And online platforms don’t always lend themselves to the complicated reality of relationships: CheaterVille was effectively a kangaroo court where the onus was on the accused to prove their innocence.

Although McGibney believed himself protected by the US Communications Decency Act, which shields the owners of websites from prosecution for material posted by third parties, he began to feel uncomfortable with what he was seeing. Eventually, in the spring of 2014, he appointed an independent arbitration service, Truth in Posting, to review content deemed untrue or malicious. McGibney says that “two out of ten” of all posts were taken down after investigation.

Naturally, CheaterVille attracted national media attention – McGibney appeared on US network television shows such as *Dr. Phil* and *Maury*. In March 2011, the site crashed after Howard Stern mentioned it on his radio show – McGibney’s servers were overwhelmed for several days. He says that, at one point, the site was receiving \$20,000 (£14,000) per month in advertising revenue. But, as time passed, his reservations about CheaterVille grew, intensified by his realisation that stalkers were posting fake emails and text messages about women they were pursuing on his site.

So, in early May 2015, he decided to shut it down. There were other, more pressing matters on his mind, concerns that would arouse vitriol, death threats and an overfamiliarity with restraining orders.

M

CGIBNEY'S ROUTE TO DIGITAL

activism came not through a computer science degree at Stanford, which lies near his home in San Jose in northern California, nor via an MBA at a prestigious business school, but through the US Marine Corps, which he entered when he was 18 after an undistinguished time at school – “I would rather have been anywhere else” – in upstate New York.

“I started doing just general admin work,” he says. “I was put in front of a computer one day and it was the strangest thing. The language back then was COBOL: I sat down and I hadn’t even been taught how to use it yet, and I was like, ‘OK, I get it.’”

McGibney was posted to the 3rd Surveillance Reconnaissance Intelligence Group in Okinawa, Japan, and began to develop skills in cyber defence. He was transferred to the Marine Security Guard Battalion at Quantico, Virginia, where he helped to protect embassies.

He developed an affinity for machines. “It made me think,” he says. “It’s amazing what you can do with a computer. Unlike people, it’s completely unfiltered – I get out of it exactly what I put into it.”

Early one warm morning in May 2015, McGibney, now 42, picks at his eggs in a 50s-themed diner – chequerboard floor tiles, red booths and The Marvelettes singing “Please Mr Postman” – in downtown San Jose. He has time to meet WIRED because his wife and three young sons are at a wedding. He is average height with the sloping shoulders of an athlete and a black beard so neatly trimmed it might be from an infomercial for facial-hair clippers. He sits with the straight back of a former member of the military and smiles

often but – at certain moments, including when he’s making a point – there’s a fortitude to his demeanour. He glances at the doorway every so often, his back to the wall in the far corner. In his wallet is a licence issued by the state of California that empowers him to carry a concealed weapon, although he says he’s not packing heat today.

McGibney says he knew that when he left the Marine Corps he would somehow make a living with code, he just didn’t know how. With the FBI headquarters nearby he considered a career in federal law enforcement, but opted instead to found a startup, SecuraTrack, which used satellite technology to locate physical assets such as cars. He sold the firm in 2003 before working in other tech businesses.

“Just because you’re protected by law doesn’t mean you shouldn’t have your own code of ethics on the site,” he says. What was happening on CheaterVille ran counter to another of McGibney’s web properties, which had become his primary focus: BullyVille, a site he launched in March 2012, that was dedicated to naming and shaming online and offline bullies and publishing stories by harassment victims.

McGibney is not his birth name. He had what he describes as a “pretty fucked-up” childhood. Given up for adoption by his birth parents, he alleges abuse at the hands of foster parents: “They were all bad and I think that from that point

forward I just had a deep hatred for any adult who was horrible towards kids,” he says. McGibney was adopted by a New York City cop, Patrick

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McGibney, and his wife Mary, who lived about an hour north of Manhattan. McGibney has a blood brother who is autistic, but the pair were separated as children. He says that Catholic Guardian – the organisation responsible for his adoption – refuses to release the records. McGibney discovered that his birth mother died recently and has no way of finding his brother.

“I can’t be part of the solution with BullyVille and then part of the problem with CheaterVille, allowing these people to use it as a platform,” McGibney explains later in a follow-up call. After the Ashley Madison (AM) data breach in July 2015, he says he was approached by investors keen to relaunch CheaterVille. “It’s everything that comes along with it,” he says explaining why he declined, “including the guilt of seeing a post that was made on your site and knowing that it might not be true and it’s destroying this woman. I can’t do both.”



There was speculation online that McGibney may have been responsible for the Ashley Madison breach – he and AM founder Noel Biderman have history. In July 2013, the two men appeared on the *Dr. Phil* show and McGibney accused Biderman of using the site as a front for escorts (which Biderman denied). McGibney denies involvement in the hack: “I can tell you from understanding how internal networks work that that is an inside job,” he says.

As much as McGibney is an outsider, and one who certainly isn’t concerned about making enemies, he is attempting to build something bigger, more akin to an entertainment company. He has ambitions to develop TV series off the back of the web properties he owns (including a dating site, CupidVille, a site focusing on tattoos, InkVille, and a new site to let people share problems and insights). He has a team of eight at his office in San Jose, where he moved after several years in Las Vegas. It’s easier here to raise funding for his websites.

To build something bigger, he might need to partner with large, conservative media companies, the shareholders of which are unlikely to be comfortable with a collaborator who once opened his front door in Las Vegas to find a man with a gun threatening to kill him. (The man’s wife had outed him on CheaterVille after discovering he’d impregnated a stripper.) McGibney talked him down.

Besides, McGibney – whose back bears a tattoo of the raising of the stars and stripes on Iwo Jima and the Marine Corps motto, “*Semper Paratus*” (always faithful), on his back – has a grander motive than the circus of online infidelity. “I wanted to go after paedophiles,” McGibney says. “I wanted to go after the worst of the worst.”

James McGibney in San Jose, California, October 2015

ONE DAY IN DECEMBER 2011, McGibney was approached by an Anonymous operative – “an old-school Marine” according to McGibney – who wanted to discuss Hunter Moore, the most notorious purveyor of so-called “revenge porn” on the internet. Moore’s website, IsAnyoneUp? (IAU), enabled people to post nude photos of their exes along with personal details such as a Facebook profile. Moore had become an internet celebrity. *Rolling Stone* published a profile of him titled “The Most Hated Man on the Internet”. The then 26-year-old was unrepentant. On CNN’s *The Anderson Cooper Show* in 2011, he told two women who’d had photos of themselves posted on his site that it was their fault for allowing the pictures to be taken. Moore maintained that he took down images when requested but victims claimed that their requests were ignored. Moore had resisted all attempts to take down his site which, in August 2011, had been receiving around 230,000 uniques per day. A series of blithe magazine profiles and unrepentant TV appearances did nothing to assist his case.

Facebook’s lawyers, Perkins Coie, sent Moore a cease-and-desist letter in December 2011 claiming that, among other breaches, he was “threatening, harassing or intimidating” users of the social network. Moore’s response, according to an interview on the gossip site Gawker, was to reply with a photo of his penis. “I’ve got to give him credit,” McGibney says now. “It was ballsy to say the least.”

McGibney and Anonymous hatched a plan.

One of the Anonymous operatives, a self-employed consultant from Illinois who goes by the handle BrutalMast3r, had got to know McGibney via Twitter. Over several weeks, a level of trust developed. “Part of the limitation of being in Anonymous is that, with things like Freedom of Information requests, you hesitate to even put in a request with your name on it because you don’t want a paper trail,” BrutalMast3r tells WIRED during a September 2015



Hunter Moore’s most notorious website, IsAnyoneUp?, enabled anyone to post nude pictures of their exes along with personal details such as their Facebook profile. McGibney was part of the team that took it down. First arrested in January 2014, in December 2015 Moore was sentenced to 30 months’ jail with three years’ supervision when released. On top of a \$2,000 fine he has been ordered to undergo mental-health evaluation while he serves his time.

phone call. “So having somebody like James who’s sort of fearless and out in front is a powerful weapon.”

Both McGibney and BrutalMast3r stress that ensuring the legality of what they were doing was a primary concern. “There are those of us [in Anonymous] who strongly believe that, whatever we do, we want to maintain legality, because that also lends credibility and integrity to what we’re doing, as opposed to just wrecking shit,” BrutalMast3r says.

Rather than confront Moore, the group settled on a stealth approach – McGibney would gain Moore’s trust, initially by advertising CheaterVille on IAU. The strategy, according to McGibney, was to “let this guy know, ‘Hey, I’m kind of like you.’” McGibney says that, after establishing a rapport with Moore, he decided to see if he might be interested in switching sides – to come and work at BullyVille.

“I really felt like I was getting through to him,” McGibney recalls. “So then I said, ‘Sell me your site’, and he said, ‘What are you going to do with it?’ I said, ‘I’m going to shut it down immediately. I’m going to forward it to BullyVille.’ And we went back and forth on that for a while and he finally agreed.”

He says he paid Moore for IAU (subject to a non-disclosure agreement) in April 2012. “So one morning all these perverts go to IAU and they expect to see their dose of daily revenge porn and it reroutes to BullyVille,” McGibney says. There, Moore explained in an open letter why he had decided to shut down IAU. “I think it’s important everyone realises the damage online bullying can cause,” he wrote.

“People flipped out,” McGibney says. “The media ate it up.” If he thought he’d managed to persuade Moore to reflect

on his behaviour, he was wrong. A few weeks later, in summer 2012, Moore took to Twitter to make lurid comments about McGibney's wife and accuse the BullyVille founder of being a paedophile. McGibney responded by suing Moore, who announced he was launching a site, Hunter-Moore.tv, a fresh revenge-porn platform on which he promised to publish people's addresses.

On December 5, 2012, Anonymous mounted a campaign called #OpHuntHunter, a DDoS attack on HunterMoore.tv, and published his personal info. "That takes it down for a day, but then it's right back and he's more pissed," McGibney says. "So now he's going to launch three more servers that are replicating and look like they're on different hosting providers."

Three months later, McGibney won his defamation suit against Moore and was awarded \$250,000 in damages. As the year progressed, law enforcement agencies set about investigating Moore and his associates. In January 2014, he was arrested on federal charges. According to the indictment, he'd paid a third party, Charles Evens, to gain "unauthorised access" to the email accounts of hundreds of people and steal photographs later published on IAU.

In February 2015, Moore pleaded guilty to aggravated identity theft and aiding and abetting in the unauthorised access of a computer. Evens pled guilty when California attorney-general Kamala Harris's office accused him of 11 counts of obtaining unauthorised access to the Gmail accounts of 11 women and altering data within those accounts. A month later, he made the same plea in federal court after admitting to hacking the email accounts of hundreds of women. In November, Evens was sentenced to 25 months in jail. A month later, Moore got 30 months.

But even as Anonymous and McGibney worked to bring Moore down, the founder of IAU was protected by the Communications Decency Act – the same law that enabled McGibney to avoid prosecution for some of the material on CheaterVille. Visit IAU today, however, and it doesn't appear that different from when Moore was running it: the site was sold to an adult entertainment company and is now hosting porn again.

JAY LEIDERMAN'S INTRODUCTION

to the world of online harassment came towards the end of 2010. Having recently become a father, the criminal lawyer based in Ventura, California, found himself at home in the evening and at a loose end. He started reading about the WikiLeaks revelations. "It was really hard not to get impassioned by the banking blockade of WikiLeaks," he says, arguing that, whatever the merits or otherwise of Julian Assange, "principles of free speech and truth telling [were] stifled by PayPal, Amazon and MasterCard." Leiderman watched as Operation Payback, an effort by Anonymous in which the sites of financial organisations and payment firms refusing to send donations to WikiLeaks, were subjected to DDoS attack.

"I was like: 'Someone's going to need a lawyer – someone's getting arrested soon,'" Leiderman says.

One night he tweeted he would be willing to represent anyone charged with hacktivism. By the next evening, he was representing Commander X, a leading figure in the Anonymous/hacktivist movement. (Commander X, real name Christopher Doyon, is now a fugitive from US justice in Canada.) Leiderman became known for representing members of Anonymous. One day, he

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received a direct Twitter message from McGibney, who praised his work.

At the time, McGibney was involved in a legal case in Texas, which he asked

Leiderman to look at. Before long, Leiderman was representing McGibney. The takedown of IAU and a similar site, IsAnyBodyDown, allied to his outsize personality and willingness to engage with the media, had brought McGibney a degree of public attention. Although a number of celebrities who had suffered harassment publicly endorsed BullyVille, he was himself now a bona fide target for online degenerates. So the site's founder was now increasingly mired in fighting online hate and slander directed at him.

The situation was exacerbated in April 2013, when McGibney revealed the identities of a number of people responsible for posts regarding the US reality TV star Kate Gosselin. Astonished by the extremity of the content on a blog called Reality Without Apologies, he purchased the site, which offered him the IP addresses behind the most outlandish comments. The revelation prompted those McGibney identified, mostly middle-aged women, to claim that they were the ones suffering harassment.

Increasingly, McGibney had become the story.

One night, in November 2013, he saw a post on BullyVille. He was used to abuse and threats, but there was something about the message posted by LongJohnSilver. "I am simply amazed that this BullyVille guy, James McGibney, is still alive," the message read. "If I was listed on his website, I would put a bullet in his head. It's as simple as that."

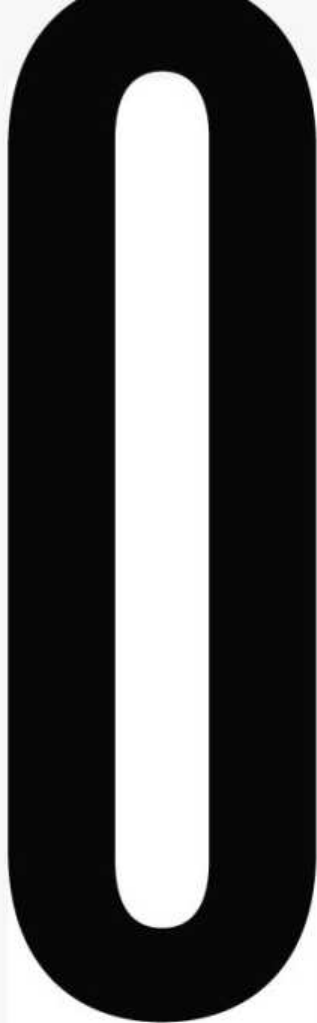
In the following weeks, he received disturbing tweets from accounts under the names of MrTexxxan and Klansmann that suggested the user, or users, knew where he lived: "It will be really funny seeing someone post pics of ur wife... when she is shopping at Smith's with ur two kids," said one.

Since then, McGibney has become embroiled, along with Leiderman and members of Anonymous, in a protracted battle against internet stalkers making extreme threats. One has a long criminal history and has, at the time of going to press, violated a restraining order 1,081 times – a Californian record. But the stalker's last known address is in another state, so it's impossible to enforce. "If he came within 100 feet of me I would not hesitate to shoot him," McGibney says. "Even at 1,000 feet I'll guess he's close enough."

"He made a post on his blog, which got shut down by WordPress: 'Who wants to murder James McGibney and his wife?' and there's pictures of me and my children," McGibney says. "But when you go to the police and say, 'Another restraining order violation', [they say] 'Yeah, but he's not doing it in California'. To really go after these people they have to be in the same state. And that's a huge problem, because if I'm going to stalk someone the lesson I've learned is stalk someone who's in Florida. I don't live in Florida: they can issue a warning, I don't give a shit."

McGibney's crusade and his complex legal battles have occurred because US law has yet to be recalibrated for an age where online criminality makes geography irrelevant. This creates huge jurisdictional problems – if your bank account in Lisbon is emptied by someone in Mexico using a server in Bangkok, who's responsible for the investigation? If you live in Buenos Aires and threaten to kill someone in Sydney, which police force enforces the law? "You have law enforcement agencies that are not well trained in digital crimes – they're downright Luddites," BrutalMast3r says.

**'SOMETIMES
YOU NEED
TO BE A BULLY TO
BEAT A BULLY.
YOU HAVE
TO STAND UP AND
FIGHT BACK'**



ON JUNE 1, 2015, THE US SUPREME Court ruled in favour of a man who'd threatened on Facebook to suffocate his wife. He'd also warned of a shooting: "Enough elementary schools in a ten-mile radius to initiate the most heinous school shooting ever imagined. And hell hath no fury like a crazy man in a kindergarten class. The only question is which one?" wrote Anthony Elonis in October 2010.

Elonis, of Lower Saucon Township, Pennsylvania, had earlier been convicted by a jury in October 2011 of five counts of threatening people through his Facebook account. Elonis, who posted under the name Tone Dougie, claimed that words were therapeutic, as he wrote in rhyme. The Supreme Court ruled 7-2 that he could not be convicted on criminal charges solely because a "reasonable person" felt threatened by his posts. His criminal conviction was overturned, but the court made no clear indication regarding the standard of proof that lower courts could use in similar cases. Elonis, it appears, was protected by the first amendment, which ensures

free speech. US law is murky, however: there are a number of restrictions on the first amendment in certain situations. For instance, "advocacy of the use of force" is only illegal if "directed to inciting or producing imminent lawless action". In other words, unless you reveal that you're headed over to kill someone that afternoon, you're protected.

The investigative journalist Robert Aschberg has seen first-hand the effects of online harassment. As the presenter of the Swedish television show *Trolljägarna*, which translates into English as the less evocative Troll Hunter, he has tracked down internet predators – from neo-Nazis to housewives – throughout the country.

"What I didn't realise when we started it was the great variations," he says. "It's not just one category. I would say that the right-wing extremists and their subculture is over-represented, but otherwise it's very varied."



ANTHONY ELONIS
Outspoken on Facebook

In June 2015, the US Supreme Court ruled in favour of Anthony Elonis, a Pennsylvanian who'd threatened on Facebook to suffocate his wife, an offence for which he had been jailed for three years and eight months. He'd also warned: "Enough elementary schools in a ten-mile radius to initiate the most heinous school shooting ever imagined." Although his words were "crude, degrading and violent", said the Supreme Court, prosecutors had not properly established intent.

Aschberg suggests that there are two factors in the rise of trolling: anonymity, and the ease of participating. "People had been beating each other with clubs and swords on the battlefield," he says. "When the musket was invented people could kill each other from 80 metres. Now those people can sit – just like they're playing computer games – in a bunker in Florida or somewhere and kill people with drones. So the distance of it has made people go a lot further than they would if they met in real life."

Like the US and UK, there has yet to be extensive research into the extent of online bullying and trolling in Sweden. "We're living in the age of the selfie, we're living in narcissistic times. So it's a paradox really, as people tend to feel that they're anonymous."

As one of Sweden's most high-profile investigative

journalists, Aschberg has received death threats for years: his deadeye stare when he confronts trolls on the street or is familiar to most Swedish TV viewers. He says that Swedish law is already applicable to online crime – there just needs to be a more consistent and robust approach from the police.

"A lot of people who are trolls on the net are criminals," he says. "We pretend 'it's just on the net'. You can't say 'I'm going to kill you' to somebody in real life, but on the net it's not taken as seriously. It's a death threat."

THE COMPLEXITY OF REGULATION has led to malicious individuals being able to take advantage of the absence of rules. McGibney talks about parents – whose children have been stalked by paedophiles – contacting him for help because they didn't know who to turn to.

"The police would try and serve a subpoena on Twitter, for example, and good luck getting Twitter to turn over records," he says. "So they'd come to Bullyville where I will go after these people and I will expose them."

McGibney claims to have a 100 per cent success rate – citing four revenge-porn sites shut down and "hundreds" of paedophiles curtailed. "Every paedophile I went after got their door kicked in, every revenge-porn site we went after went down," he says.

Although McGibney and his associates have taken down the worst sites, he still gets 400 emails a day. "There's a couple of revenge sites that I'm targeting," he says. "I don't disagree with turning the other cheek, but try that with a cyberstalker who maybe has a warrant for their arrest. They don't give a fuck about that and they won't stop. That's why our tagline became 'Sometimes you need to be a bully to beat a bully.' You have to stand up and fight back against these people."

"I'll never take my foot off the gas on people who go after children. And Bullyville allows me to do that," McGibney says. "A lot of people don't agree with it, and I just don't give a shit." ■

Greg Williams edited our special issue, The WIRED World in 2016

MEALWORMS THIS MONTH

Andy Barter took delivery of 2,000 mealworms to photograph for our future food story: "Sifting worms to find the most 'photogenic' ones was a new experience. It was fine until we realised the hot studio lights were cooking them."

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PRIME SUSPECTS THIS MONTH

Photographer Gregg Segal almost didn't shoot the star of our feature on plant-based-food company, Hampton Creek: "The kitchen had very little of the prototype 'egg' to hand – only enough for a small omelette. (The ingredients take a day to prep.) The chef made a great looking omelette, and it was set aside for us with 'Do Not Eat' signs on it. But someone (prime suspect: founder Josh Tetrick) ate it. I don't blame him, though – it tastes pretty good."

OVERHEARD AT WIRED THIS MONTH

"That's what they always say before the cover-up."
"2016. It's going to be the year of the edible insect."
"I think there's a danger of insect overload..."
"Nah, they love that shit in the Netherlands."

"It's like a SIM card, but for horses."
"You don't actually eat the ant – you just have to lick its bottom."
"I can't commit to the new *Serial* podcast until I know it definitely has an ending this time."
"It's the only non-food-themed feature. Unless he's also a cannibal?"



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THE WIRED INDEX

99.9%

Percentage of security bugs remaining in systems a year after being detected, even though a software patch is available, because firms fail to apply it



14,000

The number of codes US doctors used to classify illnesses on their diagnostic reports, up to October 1, 2015. The codes enable doctors and hospitals to claim payments from their patients' insurance policies

70,000

How many codes US doctors will have to use under a newly inaugurated, more specific classification system. Dermatologists diagnosing acne, for example, will now have to choose from among eight coded definitions

22%

Increased percentage of pregnancies among Bolivian women, if their intestines are infested with roundworms



101

The number of words making up the sentence an 81-year-old Georgia woman wants to take as her new name. The proposed moniker contains words such as "Allfoot", "predators" and "..."

10,000

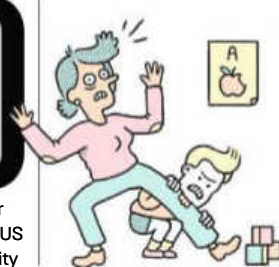
Number of attendees at a November real-estate event in Shenzhen, China. ¥6 billion (£629m) of property was sold during the six-hour session

EIGHT

Number of times Omid Kordestani tweeted between signing up to Twitter in 2010 and his official appointment as the company's executive chairman on October 14, 2015. He was previously chief business officer at Google

41,710

Americans seeking treatment in 2012 after being bitten by a human, according to the US Agency for Healthcare Research and Quality



50% \$234M

The chances of a Chernobyl-style disaster happening by 2050, according to a study into predicting future catastrophes by ETH Zurich in Switzerland and Aarhus University in Denmark

Amount Apple was ordered to pay to the University of Wisconsin-Madison after a US court found that the company had infringed a processor-performance patent

72 million

Number of computer-generated amendments Italian senator Roberto Calderoli proposed to a constitutional reform bill. They'd take 17 years to read

\$4,004,922

The amount Skarp, a project for a laser-powered razor, collected on crowdfunding platform Kickstarter in October 2015. The website eventually suspended the campaign as, allegedly, the inventors hadn't created a working prototype. It now has an Indiegogo fund, which stands at \$432,583 at time of publication

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